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Uniform Criteria for U.S. Hydropower Resource Assessment

Hydropower Evaluation Software (HES) User's Manual

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Hydropower Evaluation Software (HES) User's Manual

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ABSTRACT

The Department of Energy's (DOE) National Energy Strategy (NES) and the DOE Interagency Hydropower Resource Assessment team require a representative estimate of the hydropower development potential in this country. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering and Environmental Laboratory (INEEL) for this purpose. HES measures the potential hydropower resources available in the United States, using national uniform criteria for measurement. HES was developed and tested employing hydropower information and data provided by the Southwestern Power Administration (SWPA).

HES was originally a dBASE III PLUS and dBASE IV menu-driven software application. It has been converted into a Visual Basic application with a Microsoft Access database.

HES provides the personal computer user with the ability to assign environmental attributes to potential hydropower projects and to calculate a development suitability factor for each project based on the environmental attributes. HES also provides a report capability based on the suitability factors. This document details HES's functions, capabilities, and the assumptions exercised.

ACKNOWLEDGEMENTS

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ACRONYMS

DOE	Department of Energy
ESIS	Endangered Species Impact Study
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
HES	Hydropower Evaluation Software
HPRA	Hydropower Resource Assessment
INEEL	Idaho National Engineering and Environmental Laboratory
NES	National Energy Strategy
NPPC	Northwest Power Planning Council
NRI	National Rivers Inventory
ORL	American Rivers Outstanding River List
ORNL	Oak Ridge National Laboratory
PESF	Project Environmental Suitability Factor
PMA	Power Marketing Administration
SWPA	Southwestern Power Administration
USFWS	United States Fish and Wildlife Service

UNIFORM CRITERIA FOR U.S. HYDROPOWER RESOURCE ASSESSMENT

HYDROPOWER EVALUATION SOFTWARE (HES) USER'S MANUAL

1. INTRODUCTION

In June 1989, the U.S. Department of Energy (DOE) initiated the development of a National Energy Strategy (NES) to identify the energy resources available to support the expanding energy demands in the U.S. As a result, DOE established an interagency Hydropower Resource Assessment team to review the undeveloped resource potential in the United States. Concurrently, public hearings that were conducted as part of the NES concluded that the potential for development was not well defined. Partial analysis of the undeveloped resource database by industry groups indicated that the data includes duplications and other errors that reduce confidence in the published estimates of the developable hydropower potential.

The interagency Hydropower Resource Assessment team is made up of representatives from each Power Marketing Administration (Alaska Power Administration, Bonneville Power Administration, Waste Area Power Administration, Southwestern Power Administration, and Southeastern Power Administration), the Bureau of Reclamation, the Army Corps of Engineers, Federal Energy Regulatory Commission (FERC), Idaho National Engineering and Environmental Laboratory (INEEL), and Oak Ridge National Laboratory (ORNL). In February 1990, this team drafted a preliminary assessment that indicated about 52,900 MW of undeveloped potential.

DOE is continuing the resource assessment activities, which will provide a basis for future policy determinations and for improving current estimates of developable hydropower resources. The Hydropower Evaluation Software (HES) has been developed as a uniform criteria and probability factor computer model to standardize the assessment process. HES was developed with environmental evaluation support from ORNL. The Southwestern Power Administration (SWPA) provided the standards required by a power marketing administration (PMA). HES computer screens and report generation capabilities were developed to meet the needs of PMAs nationwide.

HES IS MEANT TO BE GENERIC. IT MEETS THE CRITERIA FOR A NATIONAL UNIFORM ASSESSMENT RATHER THAN BEING SPECIFIC TO A SINGLE MARKETING REGION.

The primary purpose of HES is to:

1. Provide the capability to create an environmental attribute database using the Hydroelectric Power Resources Assessment (HPRA) database as a foundation

2. Assign environmental attributes for each site

3. Calculate a development "suitability factor" based on the environmental attributes

4. Provide a report capability based on this suitability factor.

FERC maintains the HPRA database, which is the best available inventory of national hydropower potential. It contains information about all sites that have been subjected to any FERC hydropower licensing action. Additionally, the HPRA database contains information on project sites that have been identified by FERC, or other agencies, as having development potential even if no licensing action has taken place. The HPRA database serves the hydropower resources assessment primarily by providing a list of project sites. The HPRA database contains descriptive fields such as Plant Name, Plant Type, Stream Name, River Basin, Potential Name Plate Capacity, and Potential Annual Power Production.

The suitability factors used by HES were determined from information provided by ORNL staff experienced in the hydropower environmental area. These suitability factors are only appropriate for national or regional analyses of the overall hydropower development potential and are not useful for determining the potential of any individual project.

A Project Environmental Suitability Factor (PESF) is calculated for each project after the PMA has entered the pertinent information for each site. The PESF is used to recalculate the potential Name Plate Rating, provided by the HPRA database, for each project.

The term "Name Plate Rating" is used by this manual and HES to represent the additional potential hydropower capacity. It is not a measurement of currently installed capacity. Similarly, the term "Annual Energy Rating" is the potential additional annual energy rating, not the current annual energy produced.

The original Name Plate Rating and the PESF-calculated Name Plate Rating are provided in the various reports. **The PESF-calculated Name Plate Rating is used to compile summary reports and it <u>SHOULD NOT</u> be used to estimate an individual project's hydropower potential.** The environmental attributes and the method employed to determine the PESFs are detailed in Section 9. The various reports available to the HES user are explained in Section 6.

HES was designed as an aid to determine the potential hydropower energy in the United States. Using HES to measure a small area increases the probability of measurement error. Therefore, HES is only to be used as a national or regional evaluation tool.

This manual is intended to provide the user with an overview of HES's capabilities and an explanation of how to use the software. Some prior rudimentary computer knowledge is assumed.

2. UNIFORM CRITERIA FOR THE RESOURCE ASSESSMENT

In order to obtain a representative estimate of the hydropower development potential for the entire country, a standard set of assumptions must be used. Unfortunately, this is not as simple as just entering all of the potential sites in the country, entering the same conditions for each region of the country, turning on a computer program, and using the generated output. The many factors affecting hydropower development are not the same across the entire country, nor do they change the same way in response to varying conditions.

HES was developed as a tool to measure hydropower potential by the regional PMAs and state DOE agencies because these groups will most likely be the best source of accurate hydropower information.

HES is not intended to provide accurate potential development factors for individual sites. It can be used to provide regional or state totals. However, because HES was developed as a generic measurement tool encompassing national issues, the usage of regional and state totals must be done judiciously. Various local issues may skew localized hydropower potential totals. Employing HES as a national measurement tool will smooth any local anomalies.

HES was developed in conjunction with the ORNL (who provided essential environmental information) and with invaluable aid from SWPA. SWPA defined the database requirements and reporting capabilities required of a PMA. HES was intended to be as user-friendly as possible while still fulfilling its mission. It is menu-driven and it contains a report submenu, with several reporting formats available to the user.

The fifteen variables detailing each project were accumulated from the HPRA database. These variables are described in Section 8. Up to twenty additional variables are entered by the HES user. These twenty variables are the most critical variables as they represent the knowledge base available from each regional PMA. This knowledge base is essential to providing localized information not singly available anywhere else. Each PMA will have knowledge of possible state opposition to, and constraints on, hydropower development. They should also be able to confirm or change the information provided by the HPRA database. The twenty variables provided by the PMA include the Dam Status, Environmental Factors, and Federal Land codes. These are also explained on the following pages. This combination of codes is the basis used to determine the PESF for each project. The method for determining the PESFs is detailed in Section 9.

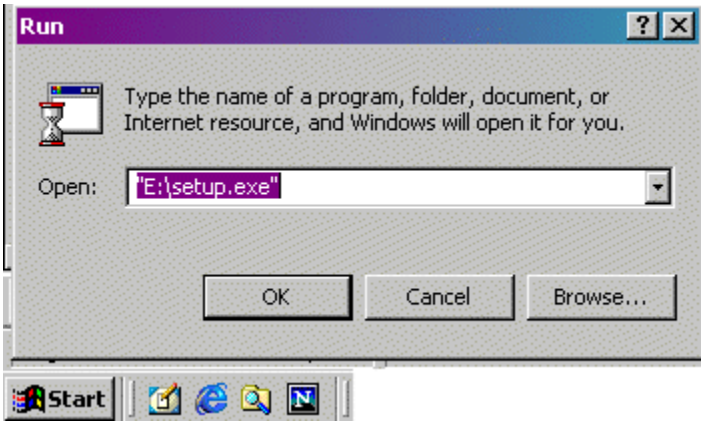
3. SETUP AND INSTALLATION

To install the Hydropower Evaluation Software program, insert the HES CD into the computer's CD-ROM drive. The installation process should begin automatically.

If the installation process does not start automatically, follow these steps:

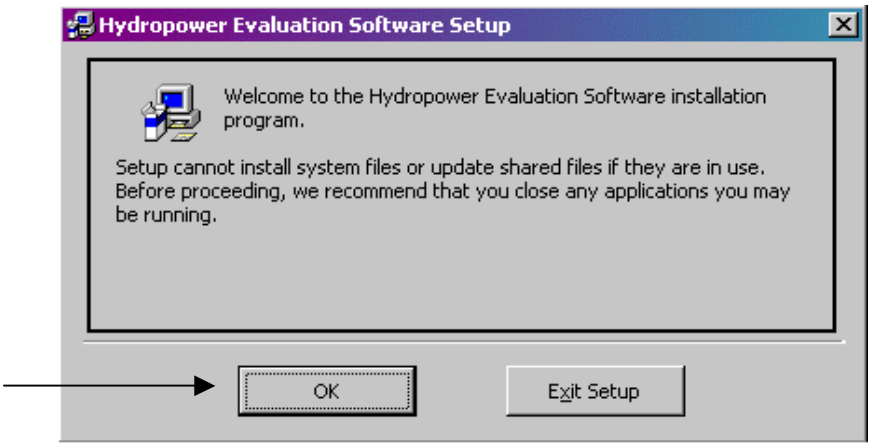
1. Go to the start menu and select "Run."

2. Type in the path of your CD-ROM drive along with the following file name: setup.exe. You may also browse the CD-ROM for the setup file by selecting the "Browse…" button.



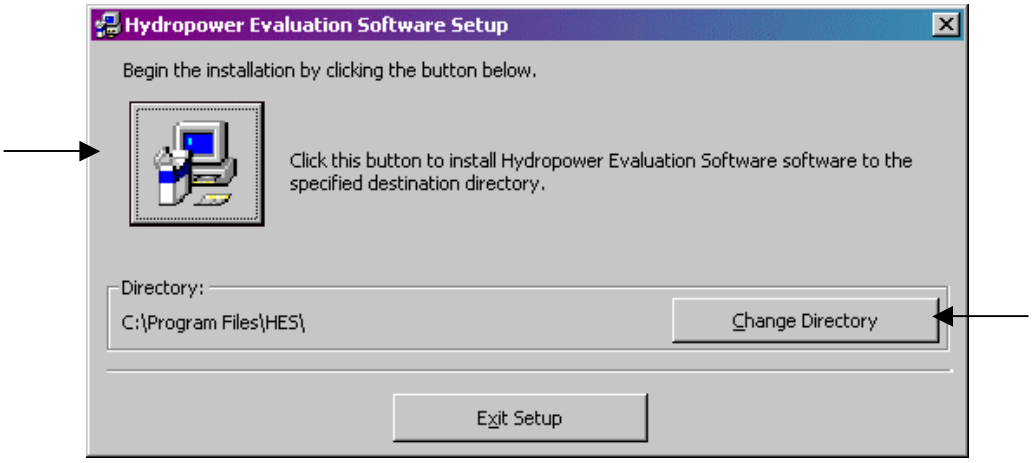
3. Select "OK."

The installation program will begin with the following screen. Select "OK" to continue with the setup process.

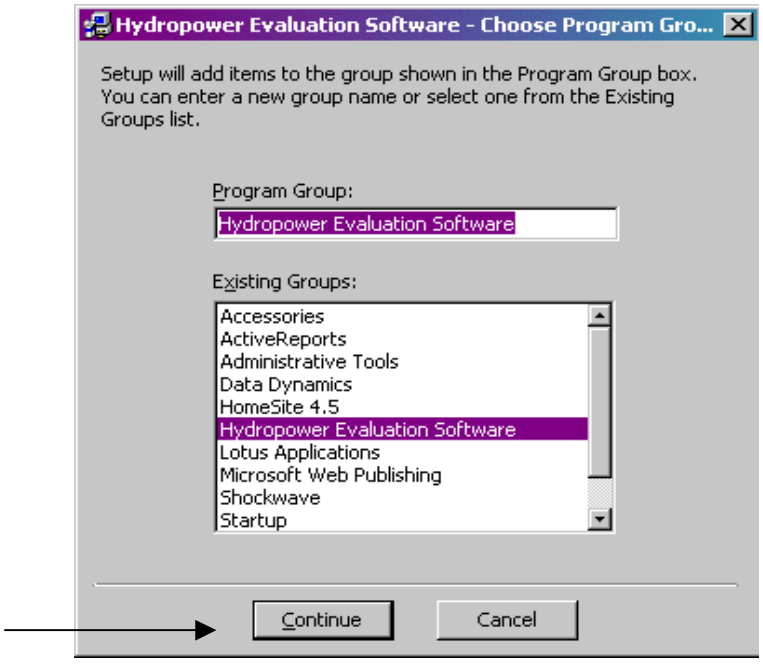


The next screen allows you to change the directory where the program installs. If you wish to install in the default directory (recommended) then select the computer icon to continue.

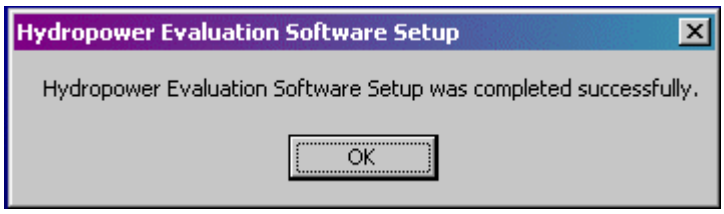
Otherwise, select the “Change Directory” button and select the directory in which you wish to install the program.



The next screen selects the Program Group. Make sure Hydropower Evaluation Software is selected. Select “Continue” to proceed with the installation.



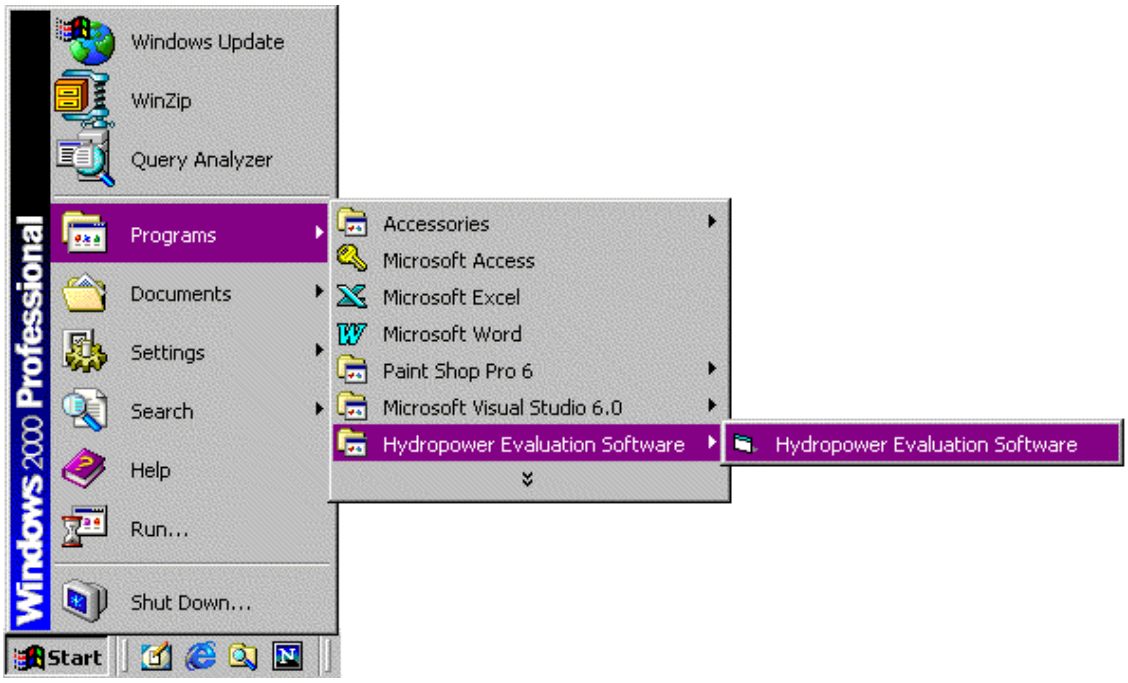
It may take a few minutes for the program to install. Once it has finished installing, you should receive the following message.



You have successfully installed the Hydropower Evaluation Software program.

3.1 Accessing the HES Program

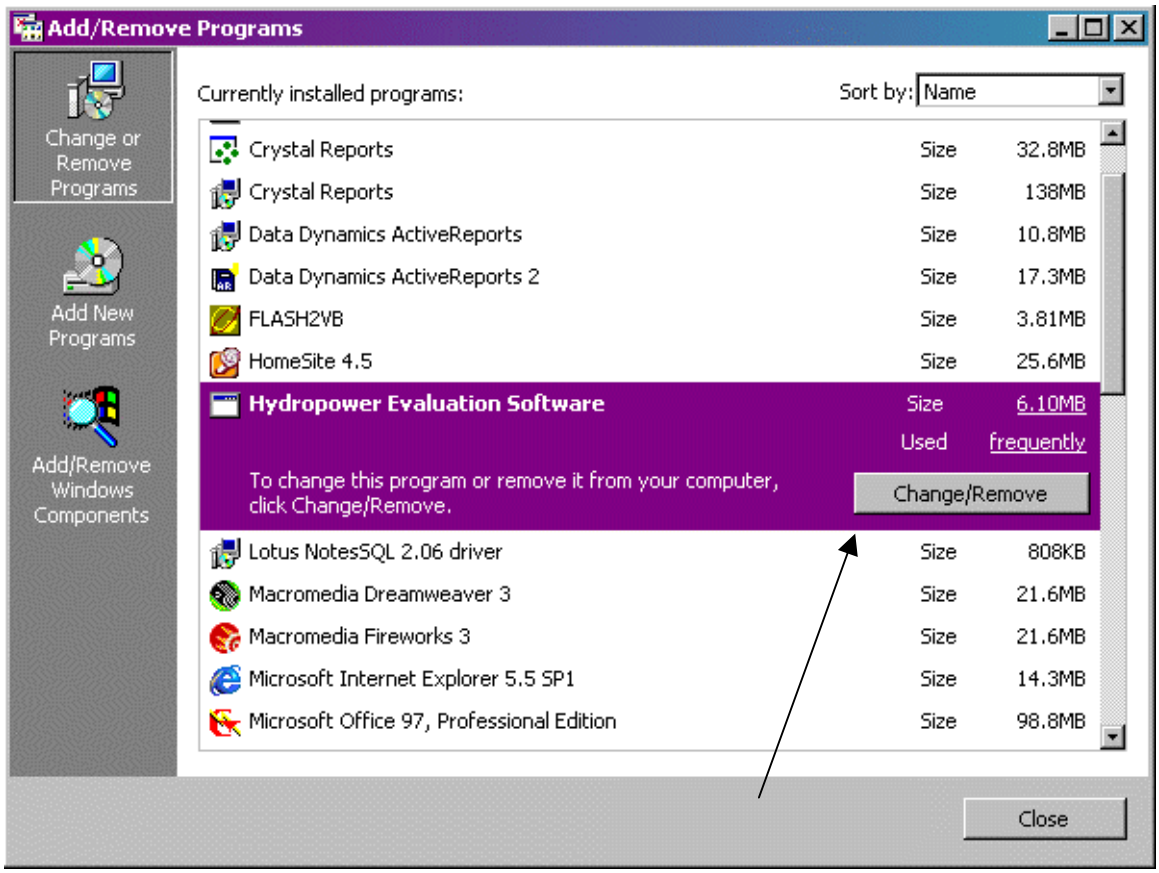
To access the program once it has been installed, go to the Start Menu then select Programs ⟶ Hydropower Evaluation Software ⟶ Hydropower Evaluation Software.



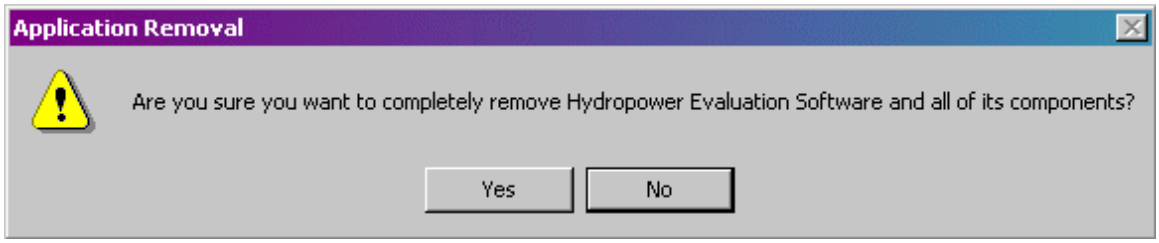
3.2 Removing the HES Software

Should it be necessary to remove the HES program, use the “Add/Remove Programs” option in Windows. If it is not removed this way, HES components may not be uninstalled properly which could lead to future problems when reinstalling the program.

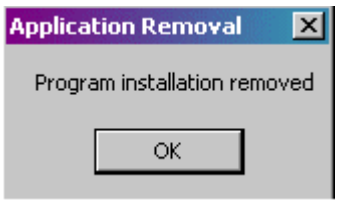
To remove the HES program, go to the Control Panel (start menu ⟶ settings ⟶ control panel) and select “Add/Remove Programs.” Select the Hydropower Evaluation Software program and click the “Change/Remove” button.



You will be prompted to confirm that you wish to remove this program. Select "Yes."



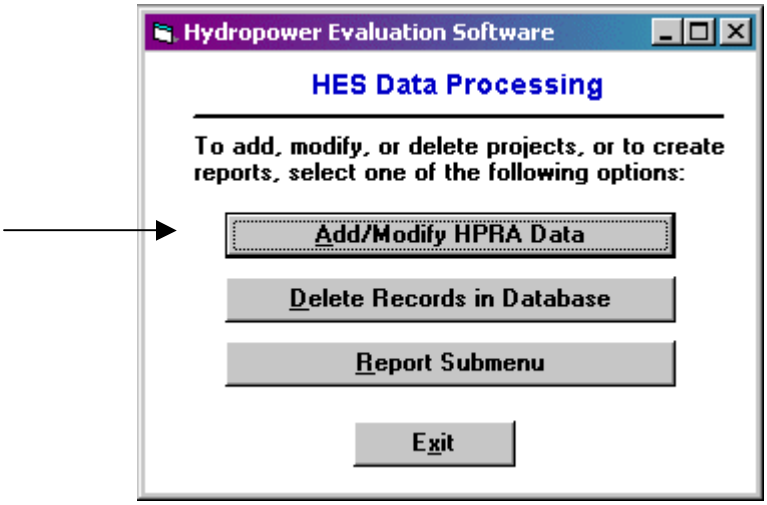
Once the program has finished uninstalling, the following message will be displayed to confirm the program was removed.



You have successfully uninstalled the Hydropower Evaluation Software.

4. ADD or MODIFY HPRA DATA

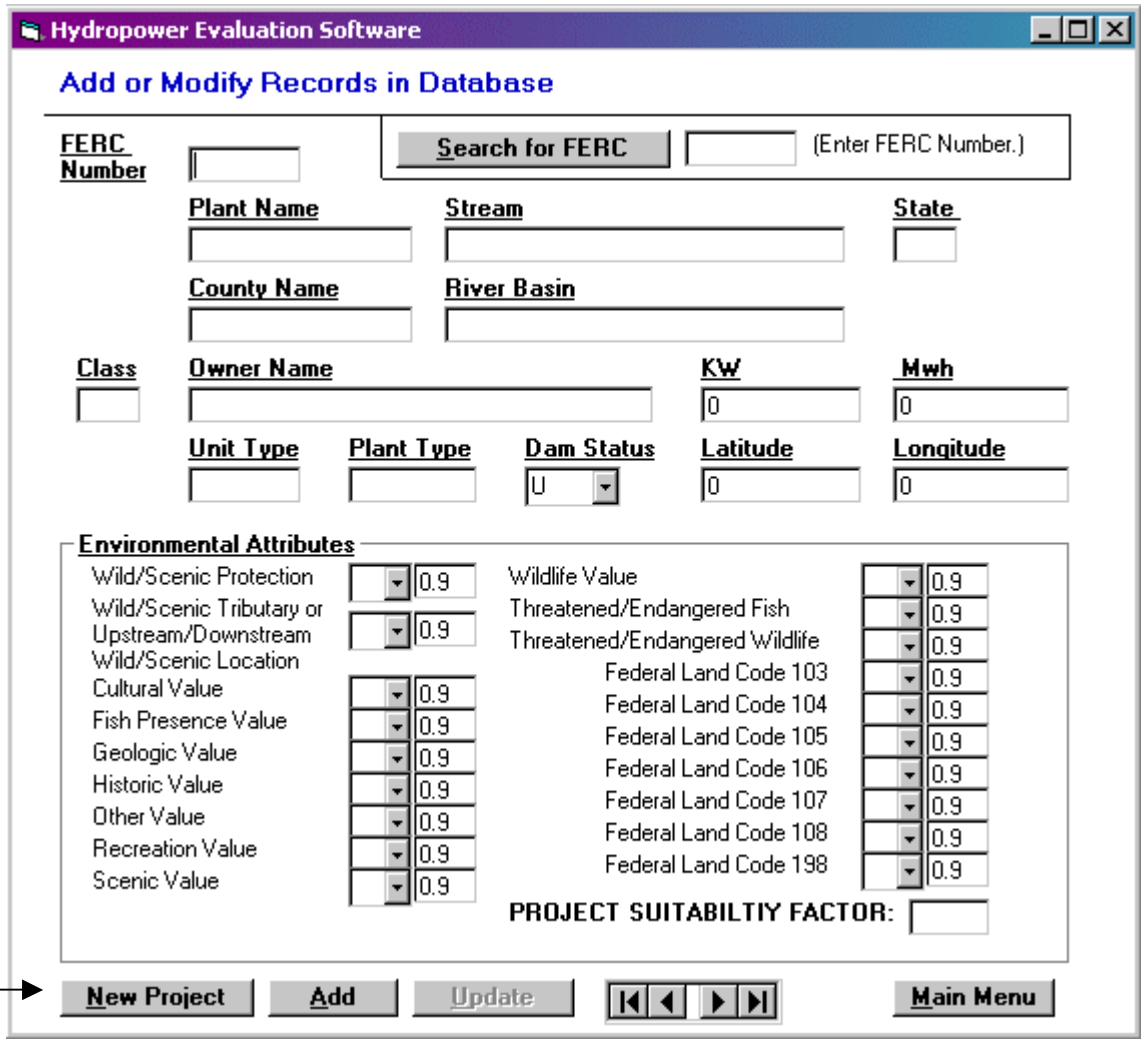
To add or modify records in the database, select the “Add/Modify HPRA Data” option on the main menu.



By selecting this option, you will be taken directly to the “Add or Modify Records in Database” form. From there, projects may be added and updates to projects and environmental data may be made.

4.1 Add Data to the Database

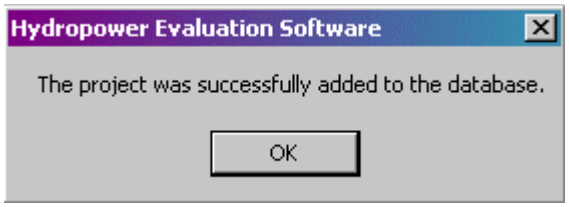
To add a new project to the database, select the “New Project” option at the bottom left side of the “Add or Modify Records in Database” form. The form will be cleared and ready for a new record to be entered.



After entering the new project, select the "Add" button. If the FERC number entered already exists, the project will not be added. The FERC number will need to be changed to a number that does not already exist.

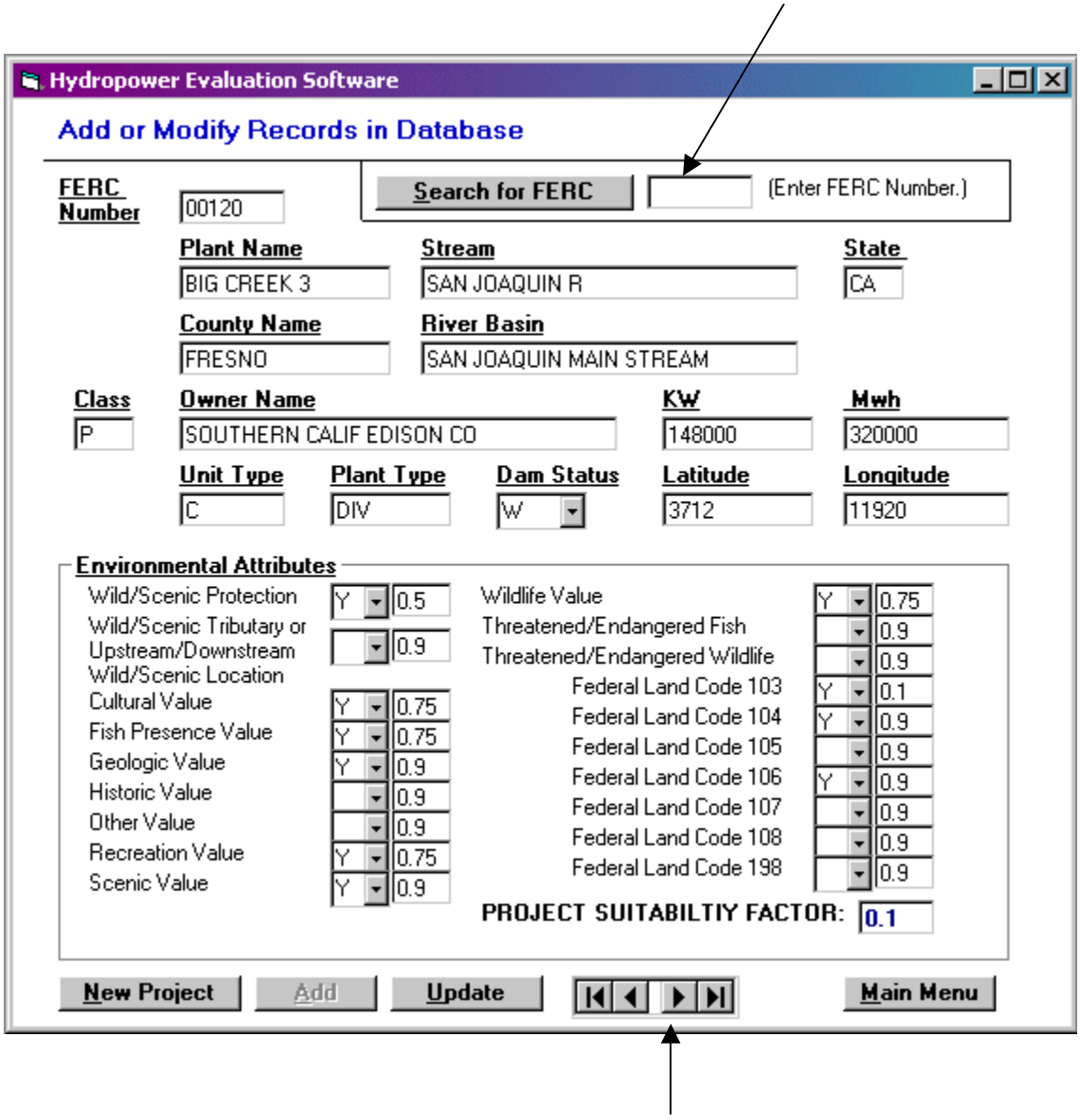
NOTE: The "Update" option will not be enabled until the record has been added. Once the record has been added, it will be enabled to allow updates to the new record. If you wish to add another record, you must select the "New Project" option again.

Once the project has been added, the following message will be displayed:



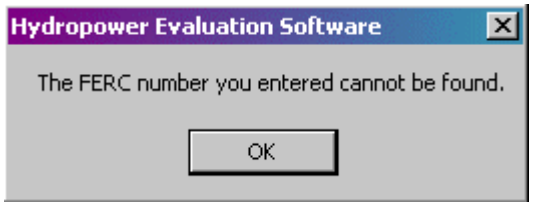
4.2 Modify Data in the Database

To modify a record in the database you must first locate the desired project. This is done by entering the FERC number in the text box of the search area (top of the form).



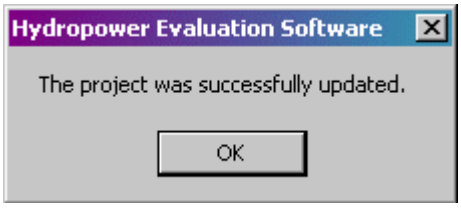
You can also toggle through the records with the forward and back buttons, but if there are a lot of records in the database this method will take much longer. If you know the FERC number, it will be easier and quicker to use the search function of this form.

If the FERC number entered in the search text box is not valid, the following message will be displayed:



If you receive this message, you must enter a valid FERC number and perform the search again.

Once you have located the desired record, any of the fields may be changed, including the environmental attributes. No changes will be made to the record until the "Update" button is selected. Once it is selected, the record will redisplay with the changes, and the project suitability factor will be recalculated if environmental attributes were changed. The following message will be displayed:

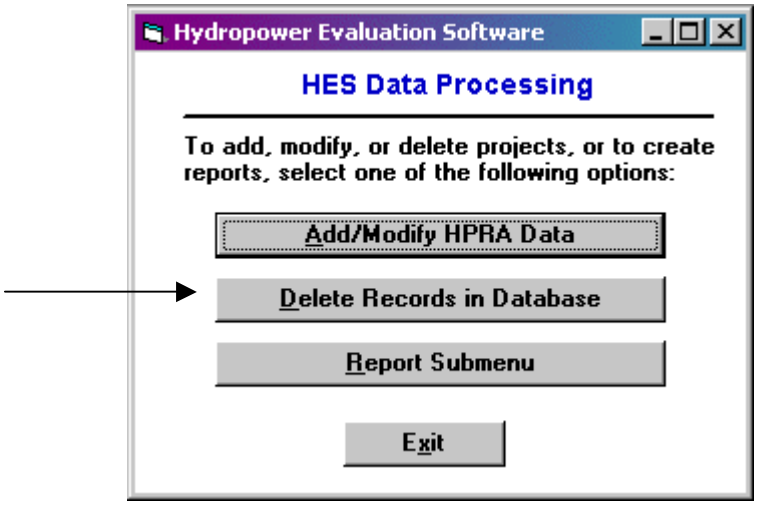


You may then search for and update another record, add a new project, or return to the main menu.

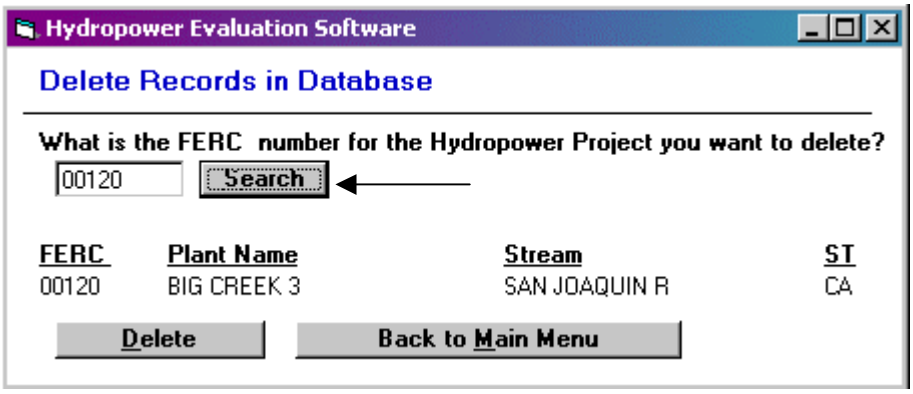
NOTE: The "Add" option is not available when updating a project unless you first select "New Project."

5. DELETE RECORDS IN DATABASE

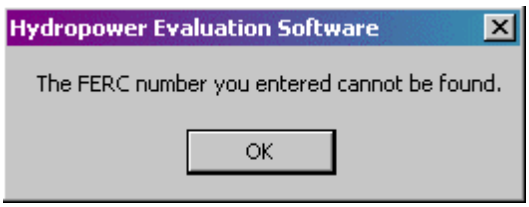
If you want to delete records in the database, select the "Delete Records in Database" option on the main menu.



When this option is selected, the following screen will appear asking which hydropower project you wish to delete. Enter the FERC number of the project and select "Search."

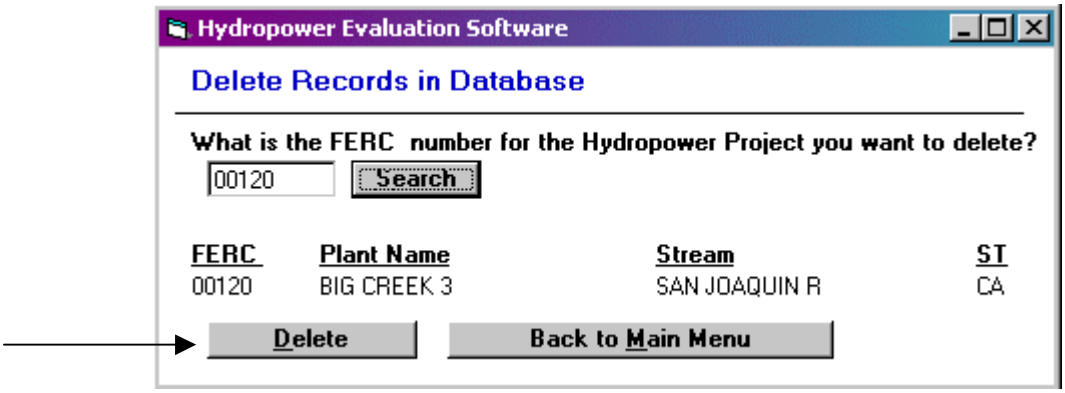


If you enter an invalid FERC number, the following message will be displayed:

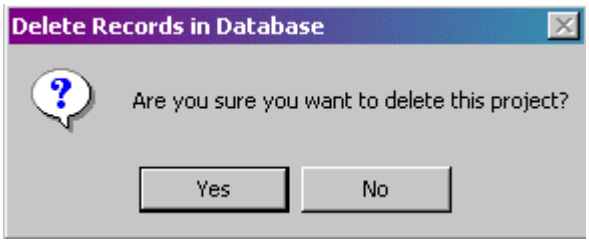


You will then be returned to the form where you may enter a valid FERC number or exit the form.

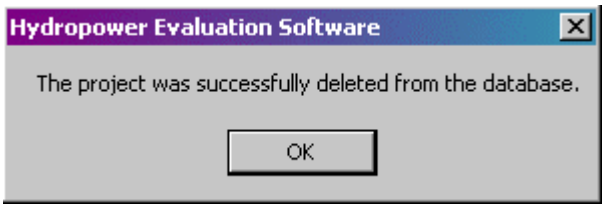
If a valid FERC number is entered and the project is found, the FERC number, plant name, stream, and state will be displayed. If this is not the FERC you wish to delete, perform the search again. Otherwise, select the "Delete" option.



You will then be prompted with the following message:



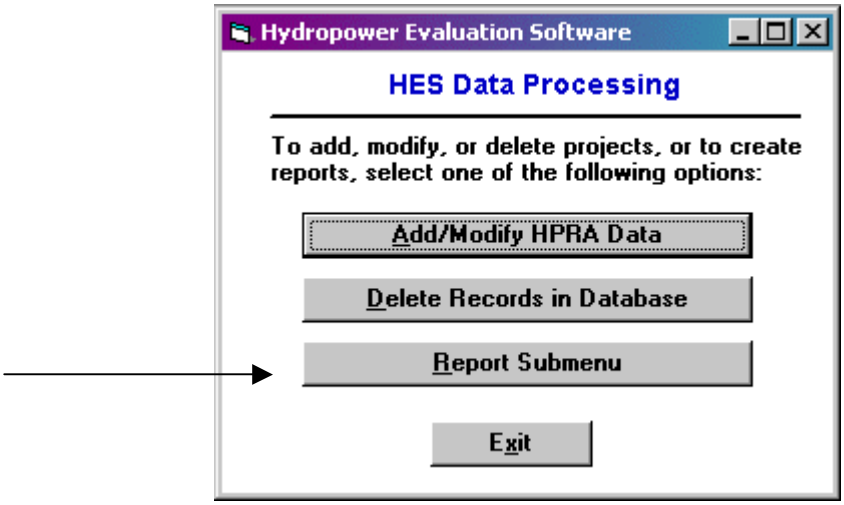
If you select "Yes," the project will be deleted and you will receive the following message:



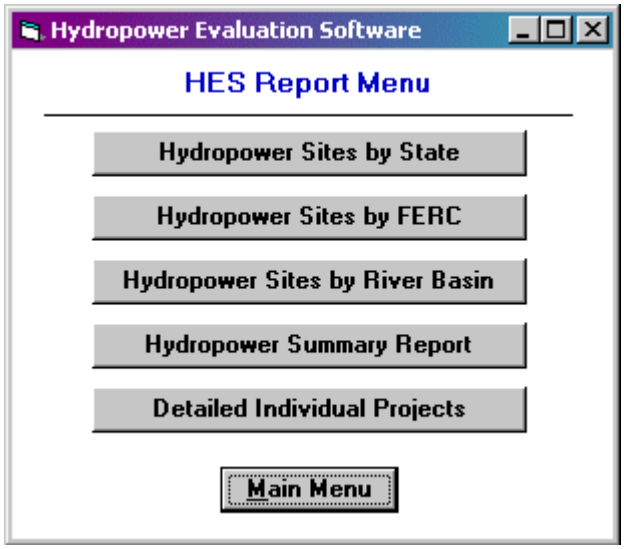
You will then be returned to the delete form where you may delete another record or select "Back to Main Menu" to exit the form.

6. GENERATE REPORTS

To generate reports, select the “Report Submenu” option on the main menu.

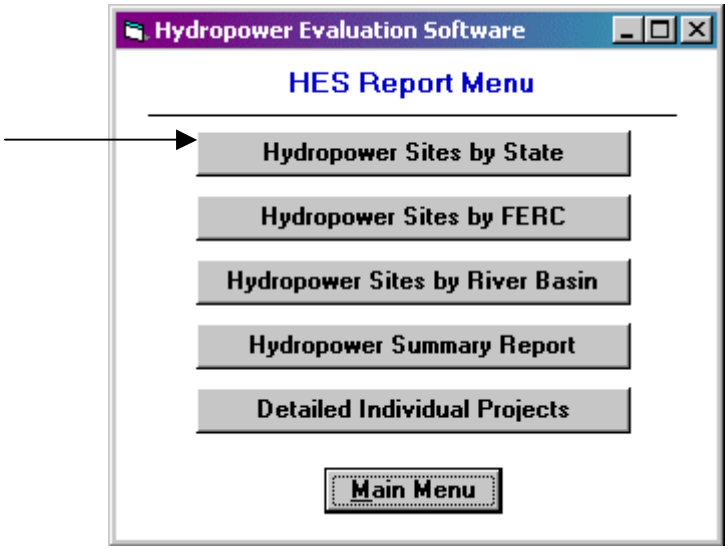


This will take you to the following form, which allows you to select the type of report you wish to generate.



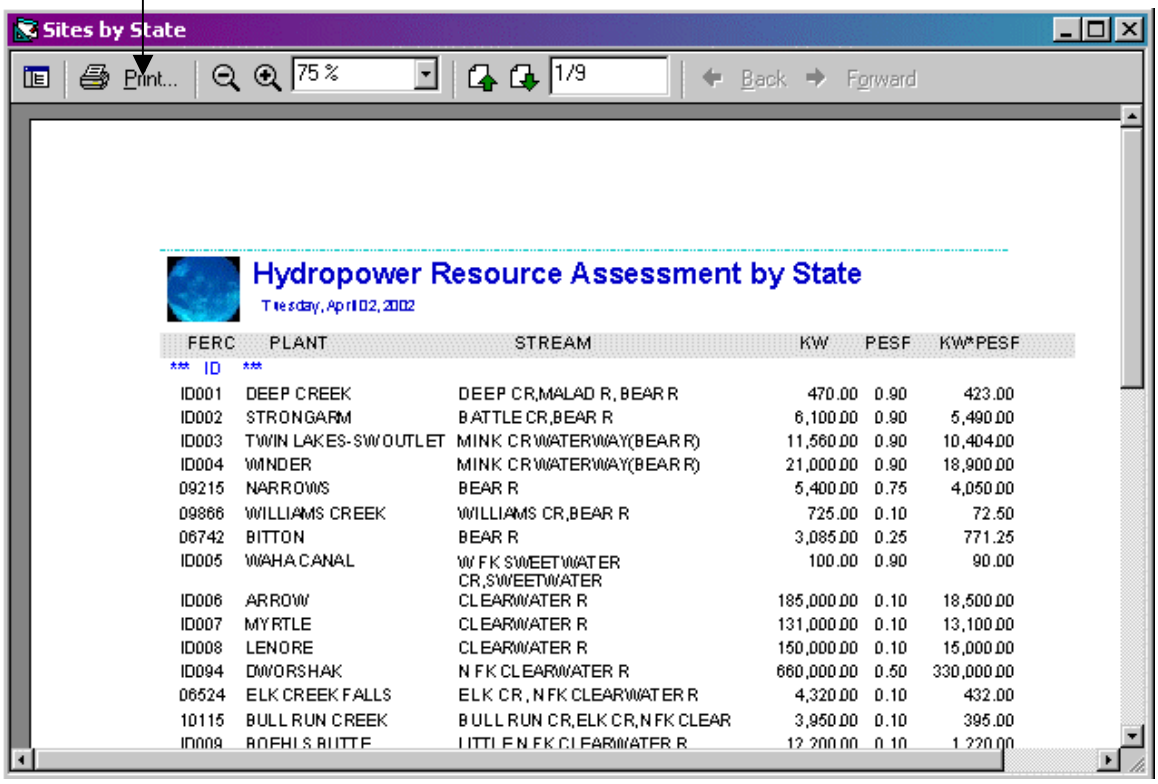
6.1 Hydropower Sites by State Report

To generate a hydropower report by state, select the first option on the report submenu.



The following form will appear, asking you to specify the state for which you are requesting this report. If you want a report on an individual state, enter the state's abbreviation in the search field and select the "Search" button. If you want a report on all hydropower projects, leave the field blank and select the "Search" button.

Following is a sample report for Idaho. To print the report, select the print option at the top of the form.

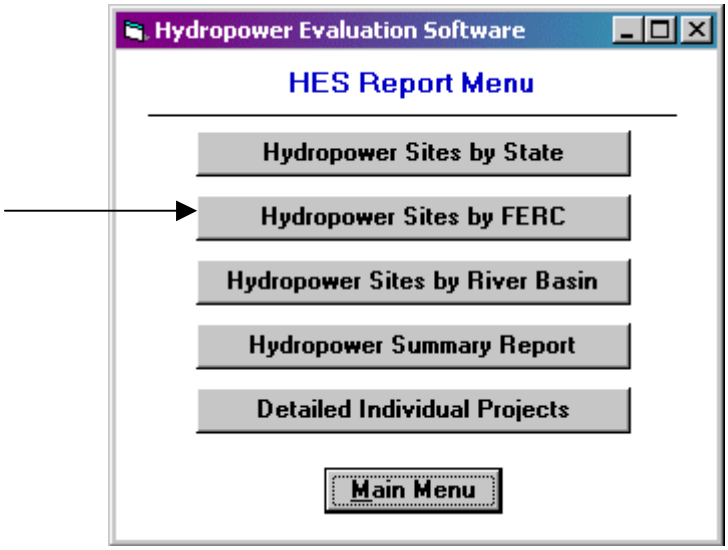


FERC *** ID	PLANT ***	STREAM	KW	PESF	KW*PESF
ID001	DEEP CREEK	DEEP CR,MALAD R, BEAR R	470.00	0.90	423.00
ID002	STRONGARM	BATTLE CR,BEAR R	6,100.00	0.90	5,490.00
ID003	TWIN LAKES-SW OUTLET	MINK CR\WATERWAY(BEAR R)	11,560.00	0.90	10,404.00
ID004	WINDER	MINK CR\WATERWAY(BEAR R)	21,000.00	0.90	18,900.00
09215	NARROWS	BEAR R	5,400.00	0.75	4,050.00
09866	WILLIAMS CREEK	WILLIAMS CR,BEAR R	725.00	0.10	72.50
06742	BITTON	BEAR R	3,085.00	0.25	771.25
ID005	WAHA CANAL	W FK SWEETWATER CR,SWEETWATER	100.00	0.90	90.00
ID006	ARROW	CLEARWATER R	185,000.00	0.10	18,500.00
ID007	MYRTLE	CLEARWATER R	131,000.00	0.10	13,100.00
ID008	LENORE	CLEARWATER R	150,000.00	0.10	15,000.00
ID094	DWORSHAK	N FK CLEARWATER R	660,000.00	0.50	330,000.00
06524	ELK CREEK FALLS	ELK CR, N FK CLEARWATER R	4,320.00	0.10	432.00
10115	BULL RUN CREEK	BULL RUN CR,ELK CR,N FK CLEAR	3,950.00	0.10	395.00
ID009	BOEHLS BUTTE	LITTLE N FK CLEARWATER R	12,200.00	0.10	1,220.00

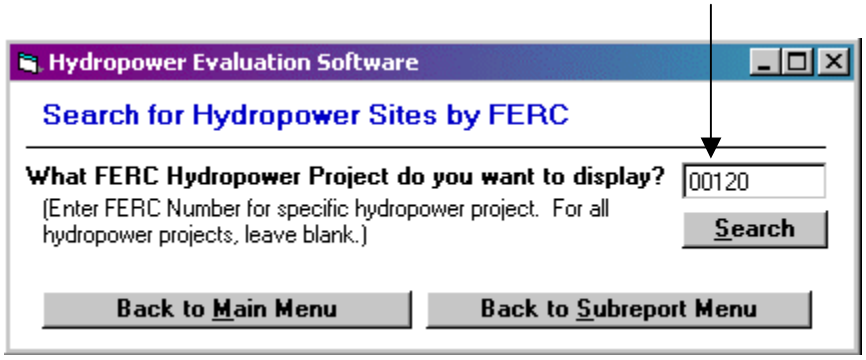
To close the report, select the “x” (close window) at the top right of the form.

6.2 Hydropower Sites by FERC

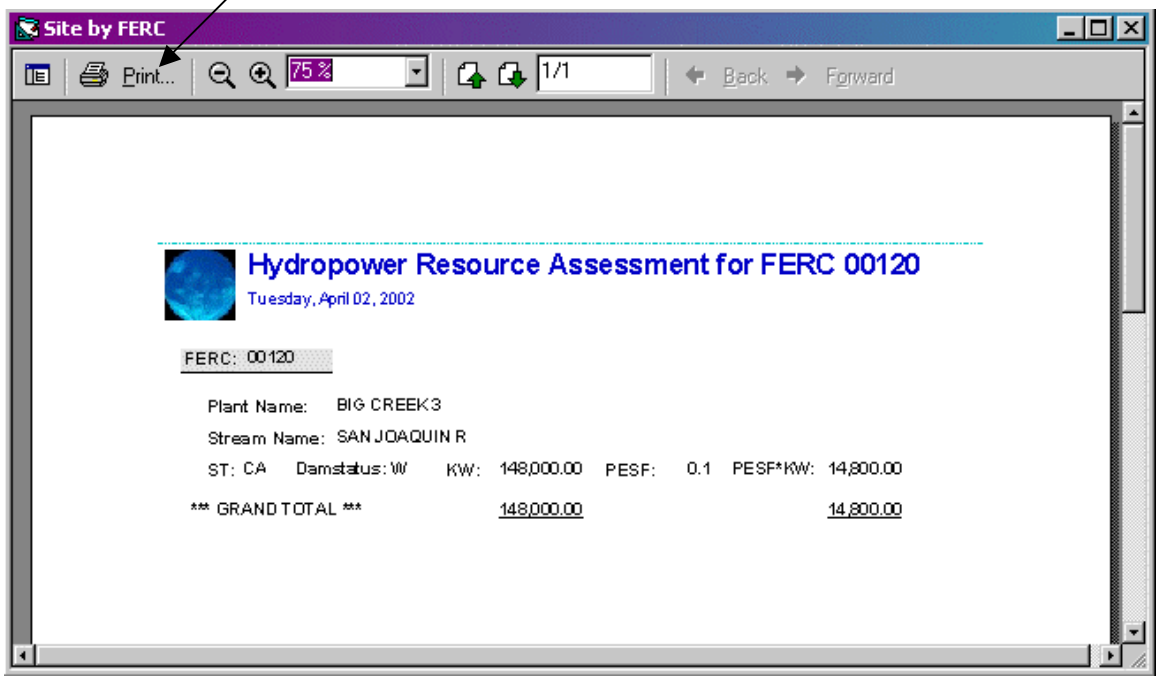
To generate a hydropower report by FERC number, select the second option on the report submenu.



The following form will appear, asking you to specify the project for which you are requesting this report. If you want a report on an individual FERC, enter the FERC number in the search field and select the "Search" button. If you want a report on all hydropower projects, leave the field blank and select the "Search" button.



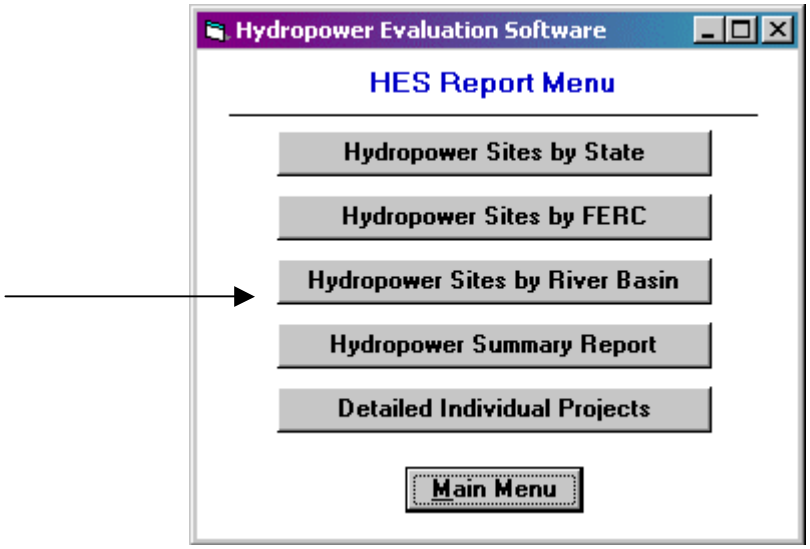
Following is a sample report for FERC 00120. To print the report, select the print option at the top of the form.



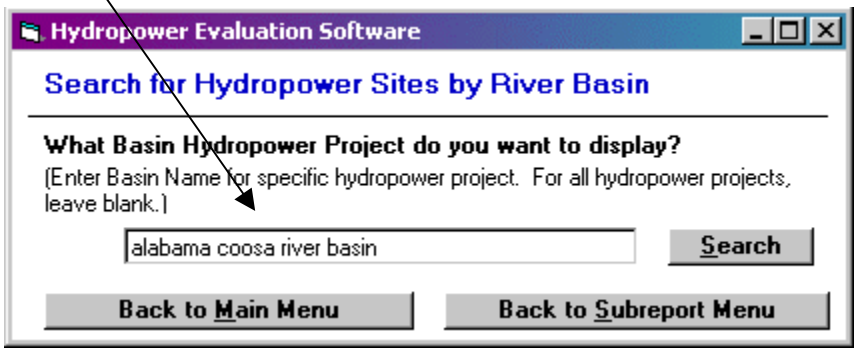
To close the report, select the "x" (close window) at the top right of the form.

6.3 Hydropower Sites by River Basin

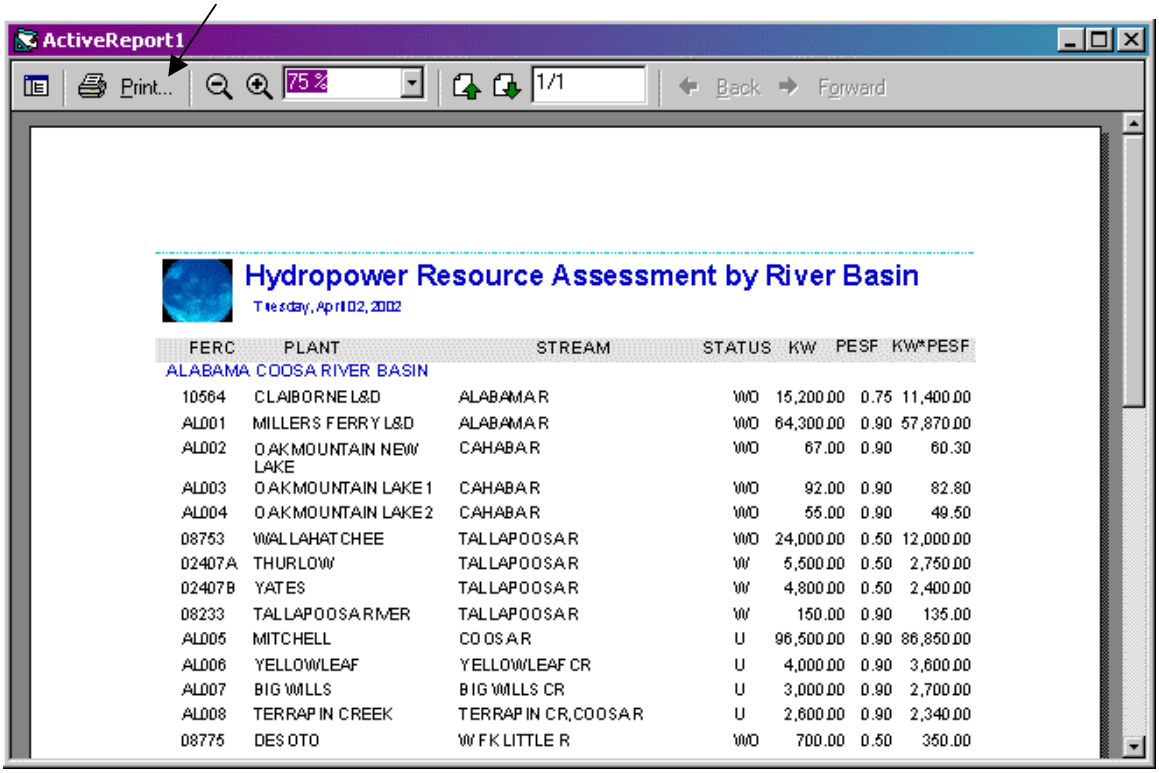
To generate a hydropower report by river basin, select the third option on the report submenu.



The following form will appear, asking you to specify the basin project for which you are requesting this report. If you want a report on an individual river basin, enter the river basin name, as it is spelled in the database, in the search field and select the "Search" button. If you want a report on all hydropower projects, leave the field blank and select the "Search" button.



Following is a sample report for the Alabama Coosa River Basin. To print the report, select the print option at the top of the form.



Hydropower Resource Assessment by River Basin

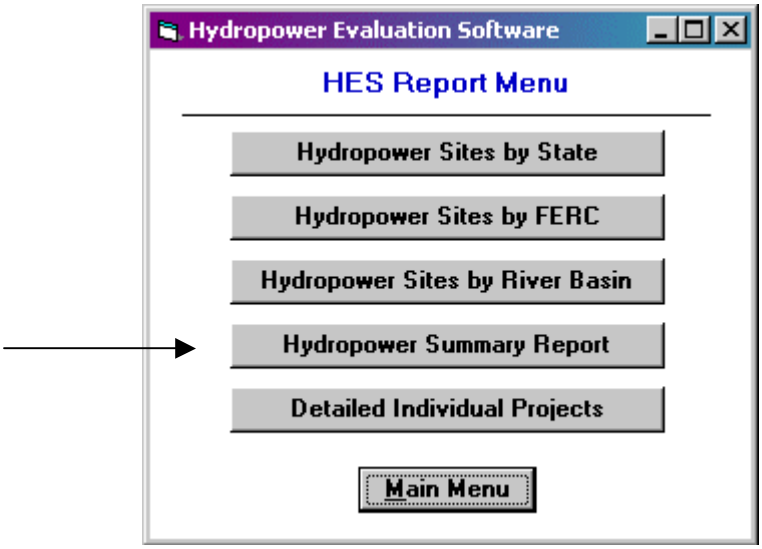
Tuesday, April 02, 2002

FERC	PLANT	STREAM	STATUS	KW	PESF	KW*PESF
ALABAMA COOSA RIVER BASIN						
10564	CLAIBORNE L&D	ALABAMA R	WO	15,200.00	0.75	11,400.00
AL001	MILLERS FERRY L&D	ALABAMA R	WO	64,300.00	0.90	57,870.00
AL002	OAKMOUNTAIN NEW LAKE	CAHABA R	WO	67.00	0.90	60.30
AL003	OAKMOUNTAIN LAKE 1	CAHABA R	WO	92.00	0.90	82.80
AL004	OAKMOUNTAIN LAKE 2	CAHABA R	WO	55.00	0.90	49.50
08753	WALLAHATCHEE	TALLAPOOSA R	WO	24,000.00	0.50	12,000.00
02407A	THURLOW	TALLAPOOSA R	W	5,500.00	0.50	2,750.00
02407B	YATES	TALLAPOOSA R	W	4,800.00	0.50	2,400.00
08233	TALLAPOOSA RIVER	TALLAPOOSA R	W	150.00	0.90	135.00
AL005	MITCHELL	COOSA R	U	96,500.00	0.90	86,850.00
AL006	YELLOWLEAF	YELLOWLEAF CR	U	4,000.00	0.90	3,600.00
AL007	BIG WILLS	BIG WILLS CR	U	3,000.00	0.90	2,700.00
AL008	TERRAPIN CREEK	TERRAPIN CR,COOSA R	U	2,600.00	0.90	2,340.00
08775	DESOTO	W FK LITTLE R	WO	700.00	0.50	350.00

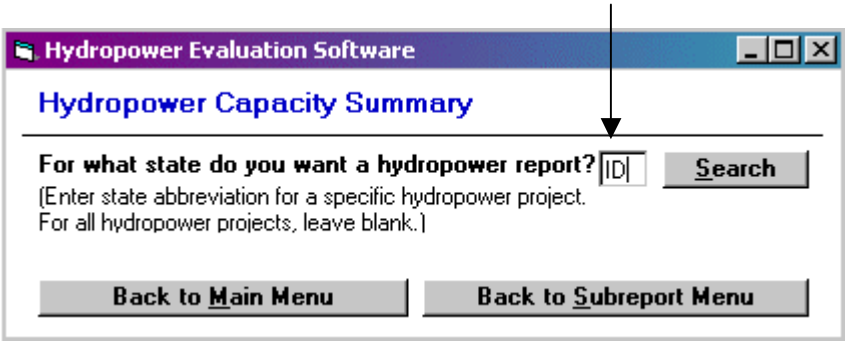
To close the report, select the “x” (close window) at the top right of the form.

6.4 Hydropower Summary Report

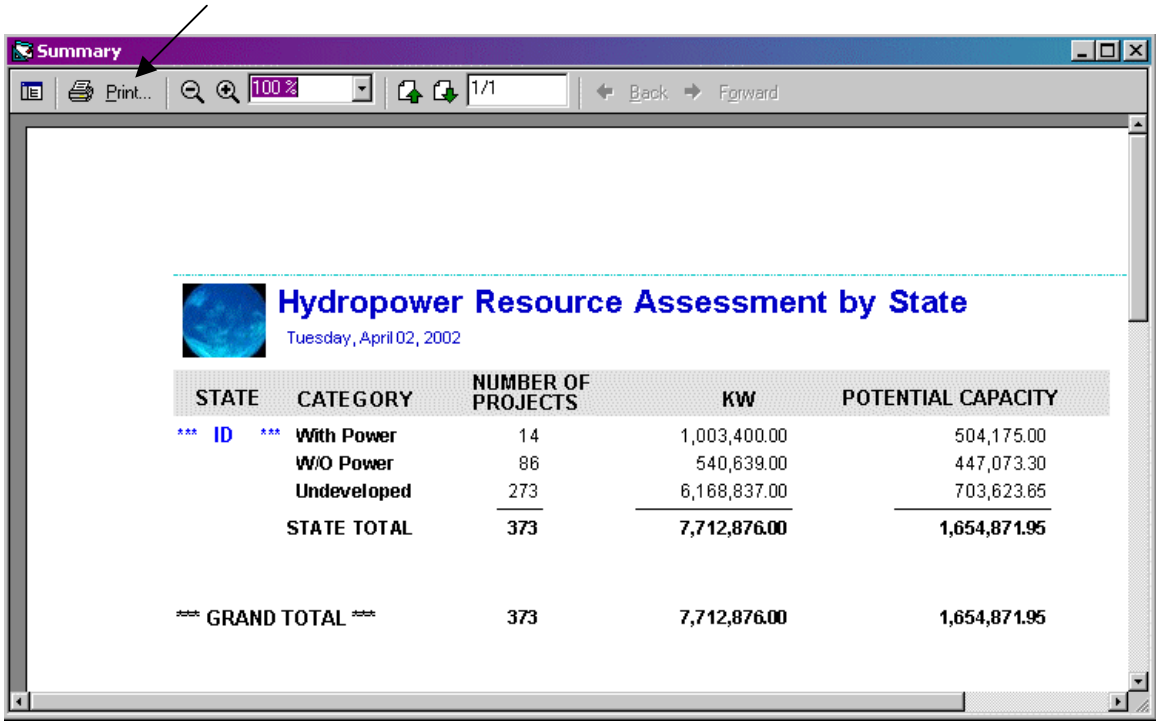
To generate a complete summary report of the database, select the fourth option on the report submenu.



The following form will appear, asking you to specify the state for which you are requesting this report. If you want a report on an individual state, enter the state's abbreviation in the search field and select the "Search" button. If you want a report on all hydropower projects, leave the field blank and select the "Search" button.



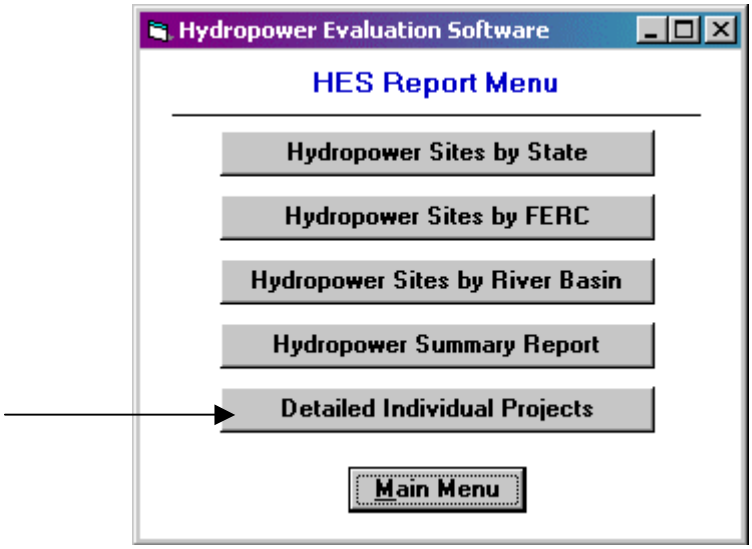
Following is a sample summary report for the state of Idaho. To print the report, select the print option at the top of the form.



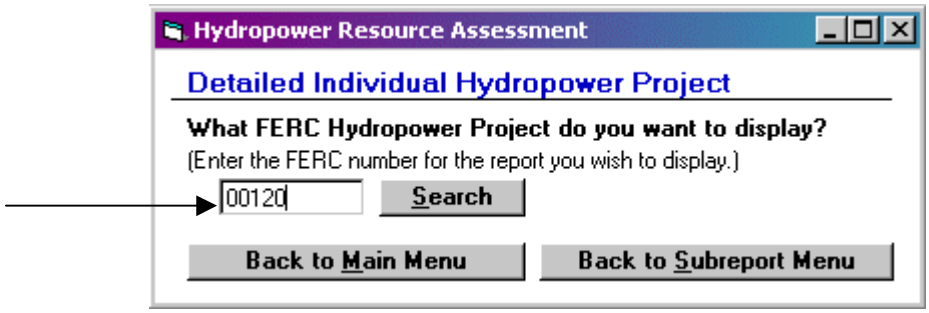
To close the report, select the "x" (close window) at the top right of the form.

6.5 Detailed Individual Projects

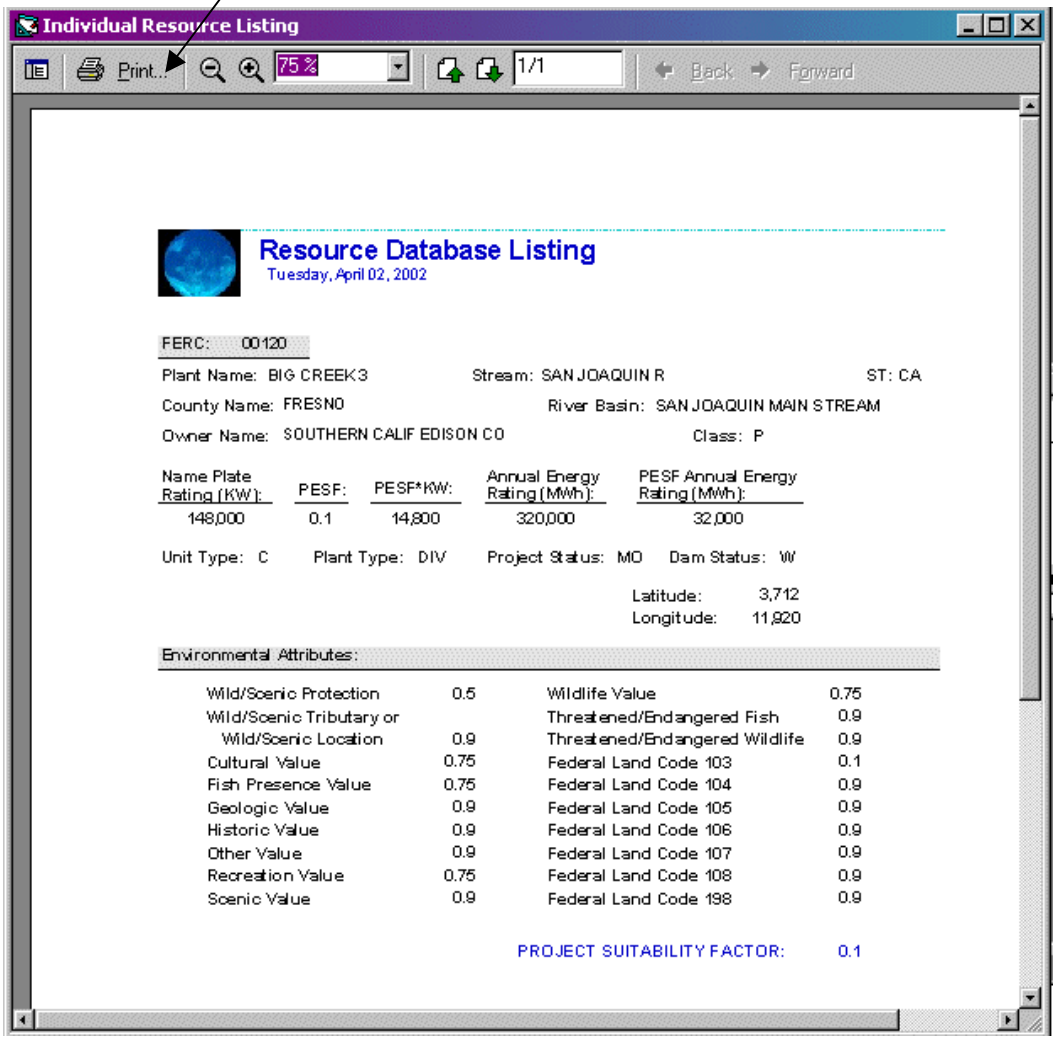
To generate a detailed report of an individual project, select the fifth option on the report submenu.



The following form will appear, asking you to specify the project for which you are requesting this report. Enter the FERC number in the search field and select the "Search" button.



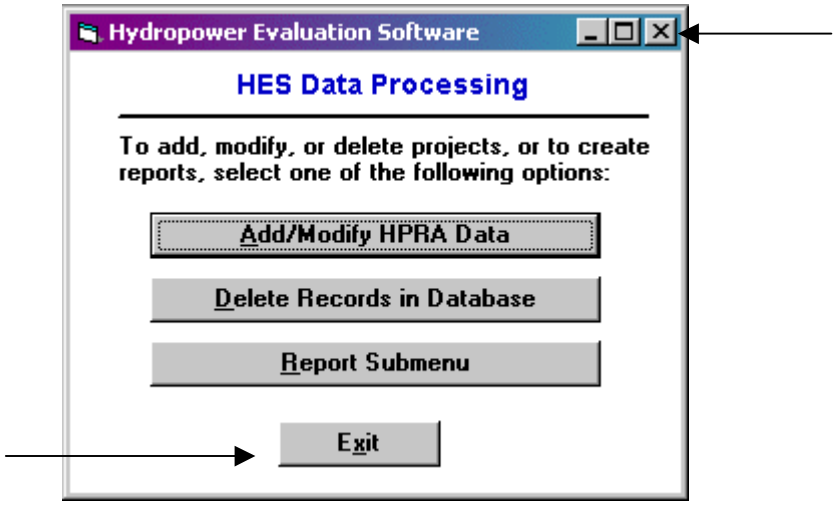
Following is a sample of the detailed report for FERC 00120. To print the report, select the print option at the top of the form.



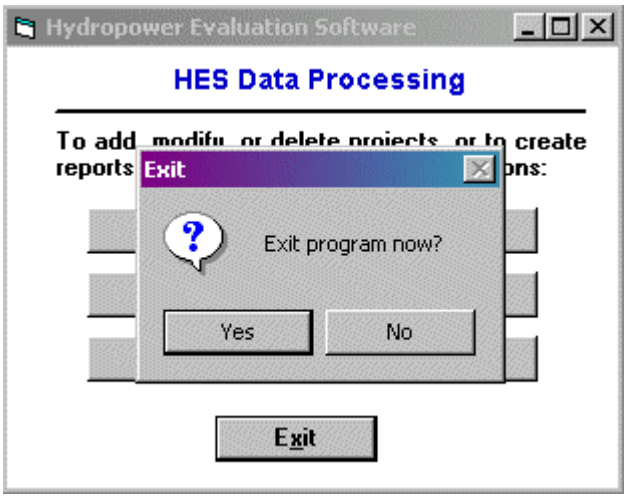
To close the report, select the "x" (close window) at the top right of the form.

7. EXIT THE HES DATA PROCESSING PROGRAM

The HES program may be exited by selecting the “Exit” button on the main menu. It may also be exited by selecting the “x” (close window) at the top right of any of the forms with the exception of the report forms. Selecting the “x” on the report forms will close the report, not the program.



If you select the “Exit” button on the main menu, you will receive a message to confirm that you wish to exit the program.



If you select the “x” at the top of the form, you will not receive a message confirming you wish to exit the program. The program will close automatically.

8. HPRA DATA VARIABLES UTILIZED

The HPRA database is maintained by FERC and it contains the best available national inventory of hydropower potential. HPRA contains information about all sites that have been subject to any FERC hydropower licensing action as well as information on project sites that have been identified by FERC, or other agencies, as having development potential even if no licensing action has taken place there. The HPRA database serves the hydropower resources assessment primarily by providing a list of project sites. There are approximately 10,250 sites for potential new hydropower development listed in HPRA.

Potential hydropower development is not limited to possibilities at new sites. It also includes development of additional hydropower at sites that currently have hydropower but are not developed to their full potential.

The following variables are included in the HES database:

1. **PROJNUM** – The number assigned to each project by FERC (in actuality the FERC number). When a PROJNUM is not assigned to a project, the PMA is strongly encouraged to provide a pseudo FERC number to be used as the PROJNUM.

2. **PLANT_NM** – Name of the project.

3. **STREAM** – Name of the stream where the project is located.

4. **STATE_NM** – Name of the state where the project is located.

5. **LAT_U** – The latitude of the lower/upper reservoir.

6. **LONG_U** - The longitude of the lower/upper reservoir.

7. **CLASS_C** – The owner class code.

   C Cooperative
   F Federal
   I Industrial
   M Municipal and other non-federal
   P Private utility
   R Private non-utility

8. **OWNER_NM** – Name of the project owner.

9. **KWRATE_P** – HPRA estimated potential Nameplate Rating (KW) of the project. This is not the current capacity at a developed site. It is the potential capacity at an undeveloped site or a site without power, or the potential additional capacity of a site that already has power.

10. **GEN_AA_P** – HPRA estimated potential Average Annual Generation (MWh). This is not the current average annual generation at a developed site. It is the potential

average annual generation at an undeveloped site or a site without power, or the potential additional average generation of a site that already has power.

11. **UNITYP_P** – Type of unit.

    C Conventional
    R Reversible
    Z Missing

12. **PLANTTYP** – The project type or type of operation.

    CMB Combined conventional and reversible units
    DIV Gravity diversion (powerhouse on different stream)
    PDV Pumped diversion (one-way pumped storage)
    PMP Pure (recycled) pump storage
    RES Reservoir only
    ROR Run-of-river (dam <= 10 ft high and minimal storage)
    RRG Reregulating
    STG Storage, conventional hydro (dam > 10 ft high with significant storage)
    TID Tidal conventional hydro

13. **STATUS_C** – Project status code.

    DJ Disclaimer of FERC jurisdiction
    EA Exemption applied for
    FA Federally authorized
    FR Federally recommended
    LE License exception
    LJ Lack of FERC jurisdiction
    MA FERC major license application
    MO FERC license outstanding
    NA FERC minor license application (<1.5 kw)
    NO FERC minor license outstanding (<1.5 kw)
    PA FERC preliminary permit application
    PO FERC preliminary permit outstanding
    XX No status
    YO FERC minor part license outstanding
    ZZ Missing

14. **BASIN_NM** – The river basin where the project is located.

15. **CNTY_NM** – The county where the project is located.

It must be recognized that not all of the above 15 variables are present for each site in the HPRA database and that the information provided is not always accurate. Each PMA should review this data to verify its authenticity.

9. PROJECT ENVIRONMENTAL SUITABILITY FACTOR DETERMINATION

Project Environmental Suitability Factors (PESF) are dependent on the characteristics of the potential projects. Suitability factors reflect (a) the probability that environmental consideration would make a project unacceptable, prohibiting its development; and (b) the degree to which environmental licensing costs and mitigation costs would reduce the economic viability of the project.

The ORNL staff experienced in hydropower licensing cases estimated the suitability factors, and these factors were selected from five potential values (Table 1). *These suitability factors are appropriate only for the regional analysis of overall hydropower development potential and are not useful for determining the viability of any individual project.*

Table 1. Environmental Attribute Evaluation

Effect Of Environmental Attribute	PESF Value
Little effect on likelihood of development	0.90
Minor reduction in likelihood of development	0.75
Likelihood of development reduced by half	0.50
Major reduction in likelihood of development	0.25
Development prohibited or highly unlikely	0.10

The effects of environmental attributes vary by Dam Status. The Dam Status classifications follow the FERC standard, which is:

W Developed Site With Power
W/O Developed Site Without Power
U Undeveloped Site

The best way to explain the influence Dam Status has on a PESF is to provide an example. Development at a previously undeveloped site would probably have a greater impact on recreation, for example, than additional development at a site that is currently developed (Table 2). So if a recreation value is present at an undeveloped site, the probability assigned to this value is 0.25. If a recreation value is present at a developed site (either with or without power) then a value of 0.75 is assigned. This reflects the likelihood that development of a site already having a structure, with or without power, is less likely to impact any recreation value. The 0.25 factor assigned the undeveloped site reflects the decreased likelihood of development of a previously undeveloped site.

When the individual values are not applicable, they are assigned a default value of 0.90. Environmental concerns are expected at some projects even if no environmental attributes are assigned, so a default value of 0.90 is used to reflect this reality. It was determined that no project should be assigned a PESF of 1.0, as this does not reflect reality.

Table 2. Individual Environmental Attribute Values

Environmental Attribute[a]	Existing Dam W or W/O	Undeveloped Site	N/A
Wild/Scenic Protection	0.50	0.10	0.90
Wild/Scenic Tributary or Upstream/Downstream, Wild/Scenic Location	0.75	0.50	0.90
Cultural Value	0.75	0.50	0.90
Fish Presence Value	0.75	0.25	0.90
Geologic Value	0.90	0.50	0.90
Historic Value	0.75	0.50	0.90
Other Value	0.75	0.50	0.90
Recreation Value	0.75	0.25	0.90
Scenic Value	0.90	0.50	0.90
Wildlife Value	0.75	0.25	0.90
Threatened/Endangered Fish	0.75	0.50	0.90
Threatened/Endangered Wildlife	0.75	0.50	0.90
Federal Land Codes[b]			
103 – National Park, Monument, Lakeshore, Parkway, Battlefield, Recreation Area	0.10	0.10	0.90
104 – National Forest, Grassland	0.75	0.50	0.90
105 – National Wildlife Refuge, Game Preserve, Fish Hatchery	0.10	0.10	0.90
106 – National Scenic Waterway, Wilderness Area	0.10	0.10	0.90
107 – Indian Reservation	0.75	0.50	0.90
108 – Military Reservation	0.75	0.50	0.90
198 – Not On Federal Land	0.90	0.90	0.90

[a] See Section 9.1 for Environmental Attribute definitions.
[b] See Section 9.2 for Federal Land Code definitions.

9.1 Environmental Attribute Definitions

Wild/Scenic Protection. Identifies project sites included in the federal wild and scenic river system, under consideration for inclusion in the federal system, included in a state river protection program, in a designated wilderness area, or protected from development under another program. Relatively few sites have such a status but those that do are highly unlikely to be developed. Projects are undeveloped sites on state or federally protected wild and scenic rivers, or in wilderness areas, and it must be assumed that the law prohibits that they be developed. Also, it is highly likely that projects at sites under consideration for protection will be opposed by state and federal resource agencies, and protection would be approved at many such sites before hydroelectric development could occur. Since it is possible, but highly unlikely, that development could occur at a site with wild and scenic river protection, the suitability value assigned to all projects at undeveloped sites is 0.10.

It is highly unlikely that a project at an existing dam would be on a wild and scenic river since rivers are usually designated as wild and scenic only if they are free of developments such as dams. A suitability factor of 0.50 is assigned for such unusual cases.

Wild/Scenic Tributary or Upstream/Downstream Wild/Scenic Location. This attribute is assigned to a project if it is at the upstream or downstream end of a wild and scenic river reach, or is on a tributary of a wild and scenic river. A project at a developed site would affect a downstream wild and scenic river if additional alterations to the flow regime resulted. A suitability factor of 0.75 is assigned for such projects. Projects at undeveloped sites are highly likely to alter the flow regime and may cause changes in downstream water quality, so a suitability factor of 0.50 is assigned to undeveloped sites.

Cultural Values and Historic Values. Project impacts on cultural and historic resources can often be mitigated (e.g., by excavating archeological sites or relocating historic structures) without great expense. Projects at existing dams are unlikely to affect such resources unless an increase in reservoir pool elevation occurs or major new structures are built. A suitability factor of 0.75 is assigned to such projects. Development at undeveloped sites is most likely to affect cultural and historic resources, so a suitability factor of 0.50 is assigned.

Fish Presence Value. A stream reach may or may not have legally protected fisheries. However, in either case, strong state opposition to new development must be expected if a valuable fishery exists. To mitigate fisheries impacts, relatively high instream flow release requirements must be expected, which reduces the economic viability of projects. Projects at developed sites could have some impacts such as increased turbine mortality. A suitability factor of 0.75 is assigned to projects at developed sites. Development at undeveloped sites could have major impacts on aquatic habitat through inundation, migration blockage, turbine mortality, water quality, and altered flows. Some of these impacts can be mitigated, but such mitigation could be expensive. A suitability factor of 0.25 is assigned to undeveloped sites.

Geologic Values. Geologic values (rock formations, etc.) are rarely protected legally and are not generally affected by small projects. Geologic resources do not affect development

at existing sites, so a suitability factor of 0.90 is assigned. Development at undeveloped sites may inundate geologic features, so a suitability factor of 0.50 is assigned.

Other Values. The effects of other values, such as the presence of rare wetland communities and consideration for wilderness designation, are assigned by using the most commonly assigned suitability factor for the other values. For projects at developed sites, the suitability factor is 0.75. For projects at undeveloped sites the suitability factor is 0.50.

Recreation. River recreation users tend to be effective opponents of hydropower development. Development at any storage dam would affect recreation by altering flow releases; mitigation typically includes higher flow releases during periods of high recreation use. Such releases can be made through turbines, but tend to occur when power demands are low. Projects at existing dams would have little effect on recreation besides flow alterations, so are assigned a suitability factor of 0.75. Projects at undeveloped sites would inundate reaches, block passage of boats, and reduce aesthetics, and therefore are likely to be strongly opposed. A suitability factor of 0.25 is assigned to undeveloped projects.

Scenic Values. Scenic values are not legally protected but must be considered in assessing the impacts of a project. Scenic values also are important to recreational users of a river. The addition of power to existing dams would alter scenic values only through the addition of new structures and perhaps by reducing visually attractive spillage, so a suitability factor of 0.9 is assigned. New projects at undeveloped sites would have important effects on scenic resources since views would be altered by the project. Undeveloped projects are assigned a suitability factor of 0.50.

Wildlife. Terrestrial wildlife and wildlife habit are protected by fish and game agencies which are influential in determining mitigation requirements for projects. Development at existing sites would have little effect on wildlife unless reservoir pool elevations are altered or construction of major facilities is required. A suitability factor of 0.75 is assigned for projects at existing sites. Development at undeveloped sites could inundate wildlife habitat and disturbance would result from construction. It is difficult to mitigate for such impacts, so opposition to such a project could be strong. Undeveloped projects are assigned a suitability factor of 0.25.

Threatened/Endangered Fish and Threatened/Endangered Wildlife. The presence of Threatened and Endangered (T&E) species near a project site requires additional consultation with wildlife agencies, and can result in additional studies and mitigation. The presence of T&E fish species may preclude development of new storage projects because they can involve the greatest alteration of aquatic habitat. Terrestrial T&E species are unlikely to be highly affected by run-of-rivers projects, but storage reservoirs could affect terrestrial habitat. For existing sites, a suitability factor of 0.75 is assigned when any T&E species are present. For all projects at undeveloped sites, a suitability factor or 0.50 is assigned when T&E species are present.

9.2 Definitions of Federal Land Codes

A Geographic Information System (GIS) map of federal lands is available from the Environmental Systems Research Institute of Redlands, California. This coverage is a digitized 1:2,000,000-scale map of the United States, created about 1982. All federal lands of greater than 10 square kilometers are included. Each PMA may already be aware

of any Federal Land Code constraints to development but the GIS map might prove beneficial.

Code 103: National Park, Monument, Lakeshore, Parkway, Battlefield, or Recreation Area. These lands are legally protected from development. A suitability factor of 0.10 is assigned for such projects.

Code 104: National Forest or Grassland. These lands are not legally protected from development but the managing agency has the right to impose additional mitigation requirements on projects. A suitability factor of 0.75 is assigned to projects at existing sites, since these projects typically have fewer impacts. A suitability factor of 0.50 is assigned for undeveloped sites.

Code 105: National Wildlife Refuge, Game Preserve, or Fish Hatchery. These lands are managed for fish and wildlife habitat and hydropower development would almost always be incompatible. A suitability factor of 0.10 is assigned for such projects.

Code 106: National Scenic Waterway or Wilderness Area. These lands are legally protected from development. A suitability factor of 0.10 is assigned for such projects.

Code 107: Indian Reservation. These lands are not legally protected from development but the Indian tribes have the right to impose additional mitigation requirements on projects. A suitability factor of 0.75 is assigned for projects at developed sites and a suitability factor of 0.50 is assigned for undeveloped sites.

Code 108: Military Reservation. These lands are not legally protected from development but the military has the right to impose additional mitigation requirements on projects. A suitability factor of 0.75 is assigned for projects at developed sites and a suitability factor of 0.50 is assigned for undeveloped sites.

Code 198: Not On Federal Land. This variable indicates that the project is not on federal land so there are no development constraints based on Federal Land Codes. The value for this variable is 0.90.

9.3 Environmental Evaluations of Projects

The final step in evaluating the environmental suitability of each project is to reduce the suitability factors for the individual environmental attributes to a single factor for each project (Table 3). The project environmental suitability factor (PESF) is an estimate of the probability of a project's successful development, considering only the attributes identified in Table 2 and their effects on project economics. The PESFs will be used to predict the contribution that each individual project makes to the aggregate energy supply curve for a region.

The PESF is a function of the suitability factors for the individual environmental attributes. The presence of more than one environmental attribute means that more than one environmental concern affects a project. The PESF should obviously be no greater than the lowest factor for individual attributes, and probably should be less than the lowest factor if multiple significant environmental concerns are present. For example, if an undeveloped project has both fish concerns (suitability factor = 0.25) and recreation

concerns (suitability factor = 0.25), the cumulative effects of these two concerns will make its overall suitability even less than 0.25, so a PESF of 0.10 is assigned.

Table 3. PESF Computation

Individual Environmental Suitability Factors	PESF
No environmental attributes assigned	0.90
Lowest individual factor(s) = 0.90	0.90
Lowest individual factor = 0.75	0.75
Two or more lowest individual factors = 0.75	0.50
Lowest individual factor = 0.50	0.50
Two or more lowest factors = 0.50	0.25
Lowest individual factor = 0.25	0.25
Two or more lowest individual factors = 0.25	0.10
Lowest individual factor(s) = 0.10	0.10

If the environmental suitability factors for individual environmental attributes were truly the probability of the project's being developed, then the overall probability of development could be mathematically calculated. And if the individual suitability factors were true and independent probabilities, then the probability of developing the project because of environmental concerns would be equal to the product of all of the individual factors. However, the FERC licensing process is not a statistical probability function and it cannot be assumed that suitability factors can be handled as independent probabilities (e.g., there is a strong correlation between the scenic, recreational, and fishing values of a stream). In addition, missing environmental attributes would bias the value of the PESF if calculated as a probability.

The procedure in Table 3 for assigning PESFs is used. This procedure assumes that the lowest suitability factor dominates the likelihood of a project's development. It also considers the reduced likelihood of development resulting from the occurrence of multiple low suitability factors.

10. ADDITIONAL DATA SOURCES

This section lists data sources that are available to identify project locations and to assign environmental attributes to these locations. There are a number of additional databases that could be used to assign environmental attributes to projects. Some of these are national in coverage, while others are only available for smaller areas such as individual states. Each additional database used would require data management efforts to obtain the database from its source and manipulate it into a form from which attributes can be assigned to projects.

Power Marketing Administration

The significant information available from each Power Market Administration (PMA) is of primary importance to the successful application of HES. Each PMA can verify any outside sources of data used, but of greater importance, each PMA will provide significant input as to events affecting potential hydropower development within his/her region. The PMA will be aware of possible state opposition and/or any localized action regarding a specific project.

Nationwide Rivers Inventory

The National Park Service completed the Nationwide Rivers Inventory (NRI) in 1982. Park Service regional offices have systematically collected information on rivers and identified those with outstanding resources. Uniform procedures of identifying rivers for the NRI were applied throughout the country and these procedures included field and map verification of each river's values. For those river reaches selected for inclusion in the NRI, specific outstanding resources were identified: NRI reaches are flagged if outstanding fisheries, wildlife, geologic features, historical resources, cultural resources, recreation resources, scenic values, or other resources are present. The NRI also includes notes indicating the presence of threatened and endangered species classified as fish or terrestrial wildlife, and whether the NRI reach is part of, or considered for, inclusion in a state or federal wild and scenic rivers program.

Because the NRI was selected following systematic consideration of potential rivers using uniform procedures throughout the U.S., the assumption could be made that if a project is not on an NRI reach then there would be few environmental impediments to development. However, projects proposed for small headwater streams that were not considered for inclusion in the NRI are subject to environmental constraints such as instream flow requirements. Significant resources (e.g., fisheries or recreational uses) may have developed since the NRI was compiled. Environmental concerns will also occur at some sites not eligible for inclusion in the NRI.

Environmental attributes for projects on NRI stream reaches can be assigned several ways. The first and simplest is to assign the environmental attributes of an NRI reach to any project in the same state, county, and river basin of each project. This method relies only on the county and river basin identifiers in HPRA for location, which are unlikely to be inaccurate. When using this method, errors could arise because projects in the same county and river basin as an NRI reach may not actually be on the stream reach.

A second method to assign NRI attributes to projects is to:

1. Use the river mile designations for NRI reaches to locate the reaches on FERC river basin maps,

2. Use the GIS to map the projects at the same scale, and

3. Overlay the project maps on the NRI reach maps to see which projects fall on NRI reaches.

This method is potentially more accurate since only the projects actually on the NRI reach would be identified. Sites within a specified distance upstream or downstream of the NRI reach could also be identified and assigned the environmental attributes of the NRI reach. The main disadvantage of this method is that it uses the latitude-longitude coordinates of projects from HPRA, which are occasionally missing or inaccurate.

State Environmental Databases

Many states have inventories of aquatic and riparian resources. These can include lists of high-quality and possibly protected fishing streams, natural areas, and recreation resources. Plans for development of a waterway, filed by state with FERC, can limit sites for hydropower. State data are often very useful in determining the environmental feasibility of hydropower sites but may require a major data management effort to incorporate into a regional database for hydropower evaluation. Little state information is available in a digital format, so it would not be easy to include in the HES database. An example of a state database is the California Department of Fish and Game Wild Trout Program inventory that lists streams identified as providing outstanding trout fisheries, which are protected from development under California law. As another example, the state of Utah has rated each of their streams in the following categories:

1. Type of fishery

2. Productivity

3. Reproductive success

4. Spawning habitat

5. Aesthetics.

Projects on streams with high ratings in these categories would have greater environmental concerns.

American Rivers Outstanding Rivers List

In 1988, an organization named American Rivers published the American Rivers Outstanding Rivers List (ORL). The ORL is a comprehensive nationwide compilation of rivers that possess some outstanding ecological, recreational, natural, cultural, or scenic value. Both rivers protected by legislation and rivers currently unprotected are included. The ORL contains approximately 15,000 river segments, totaling about 300,000 river miles. Each river segment is described in such terms as its upriver and downriver end

points, total length, significance of the stretch, and source of information. Some of this information is redundant with the Nationwide Rivers Inventory, which is included within the ORL, but much is additional information.

Northwest Power Planning Council Stream Ratings

Streams under the jurisdiction of the Bonneville Power Administration have been studied by state and rated by the Northwest Power Planning Council (NPPC) for the suitability of additional hydropower development. These ratings were for values such as anadromous fish presence, resident fish populations, wildlife, natural features, cultural features, and recreation. In 1987, the NPPC published a list of streams deemed unsuitable for hydropower development. In general, streams containing anadromous fisheries were considered unsuitable. For projects proposed in the Bonneville Power Administration marketing area, the NPPC stream ratings are an important source of environmental attributes.

Wetland Inventories

The presence of wetlands that could be affected by a project is an important environmental attribute because wetlands are protected under the Clean Water Act. The U.S. Fish and Wildlife Service has inventoried wetlands in some regions, and maps of such wetlands are available. Wetland inventories are also available from some states.

Data Sources for Threatened and Endangered (T&E) Species

1. **US Fish and Wildlife Service (USFWS) Endangered Species Impact Study (ESIS) T&E Database.** Geographic information is by count and hydrologic unit, and sometimes at finer resolution. Species information includes location, life histories, legal histories of designation as T&E, habitat use, bibliographies, contact people, and key words that identify aquatic, wetland, riparian, and species. The USFWS system has been in transition between in-house development and contracted management (by the Nature Conservancy) for several years. It appears that a wealth of information exists but may be difficult to access.

2. **The Nature Conservancy.** The Nature Conservancy has a national database of all species, with T&E species identified. Geographic information is by county. The contact is Bob Jenkins, Nature Conservancy, Arlington VA, 703-841-5300.

3. **USFWS Gap Analysis Project.** This is a state-by-state project designed to identify species-rich areas that are not legally protected. Three databases are being developed for each state:

   - Locations of all species
   - Vegetative coverage
   - Land ownership.

   Aquatic species are not yet included. The states where this project is underway are Idaho, Utah, Oregon, California, and Colorado. The addition of ten more states is being planned.

11. LIMITATIONS AND APPLICABILITY

HES is not intended to model the likelihood of development of a single, specific, hydropower project. To perform this function HES would have had to encompass the many site-specific factors affecting a distinctive site. With so many unique sites in the nation an unmanageable number of single-site specific attributes would be required. The result would be that the model's size would be so large as to be burdensome to use. Also, HES would fail to provide a uniform, nationwide, criteria for evaluation. For instance, in the Pacific Northwest this may have included any outcomes from the "Salmon Summit," the attempt to aid the migration of salmon and steelhead. This consideration would have been unique to only the Northwest area, not the majority of the United States. Additionally, if a single state decreed that there would not be any additional hydropower development within its boundaries, HES would fail in its mission if it included an attribute unique to that single state but not pertinent to the remaining 49 states. If there is significant state opposition, it will most likely be based on factors such as fish and recreation values. HES is designed to model such a situation, and if the site is undeveloped and fish and recreation values are present then HES would assign a PESF of 0.10. Tests conducted with SWPA and, through them, several states indicated that the HES model does satisfactorily model local concerns affecting hydropower when legitimate constraints to potential development are present. The model provides a uniform evaluation of hydropower potential and it should be used to accumulate regional potential, not individual project potential. Summing the regional totals provides a national aggregate of the potential hydropower resources available.

12. DATA DICTIONARY

The first 15 fields in the resource database are imported from the HPRA database. The definitions of these 15 fields can be found in Section 8: HPRA Data Variables Utilized. The remaining 40 variables in the resource database are either input by the PMA user or generated by HES. The data structure is listed in Table 4. The definitions for each field name can be found in the data dictionary.

Table 4. Data Structure of Resource Database.

Field	Field Name	Type	Width	Decimals
1	PROJNUM	Text	7	
2	PLANT_NM	Text	26	
3	STREAM	Text	30	
4	STATE_NM	Text	2	
5	LAT_U	Number	8	2
6	LONG_U	Number	8	2
7	CLASS_C	Text	1	
8	OWNER_NM	Text	35	
9	KWRATE_P	Number	12	2
10	GEN_AA_P	Number	12	2
11	UNITYP_P	Text	1	
12	PLANTTYP	Text	3	
13	STATUS	Text	2	
14	BASIN_NM	Text	26	
15	CNTY_NM	Text	23	
16	DAMSTATUS	Text	3	
17	W_S_PROT_C	Text	1	
18	W_S_PROT_P	Number	4	2
19	W_S_TRIB_C	Text	1	
20	W_S_TRIB_P	Number	4	2
21	CULTUR_C	Text	1	
22	CULTUR_P	Number	4	2
23	FISH_C	Text	1	
24	FISH_P	Number	4	2

25	GEOL_C	Text	1	
26	GEOL_P	Number	4	2
27	HISTORY_C	Text	1	
28	HISTORY_P	Number	4	2
29	OTHER_C	Text	1	
30	OTHER_P	Number	4	2
31	REC_C	Text	1	
32	REC_P	Number	4	2
33	SCENIC_C	Text	1	
34	SCENIC_P	Number	4	2
35	WILDLF_C	Text	1	
36	WILDLF_P	Number	4	2
37	T_E_W_C	Text	1	
38	T_E_W_P	Number	4	2
39	T_E_F_C	Text	1	
40	T_E_F_P	Number	4	2
41	FED103_C	Text	1	
42	FED103_P	Number	4	2
43	FED104_C	Text	1	
44	FED104_P	Number	4	2
45	FED105_C	Text	1	
46	FED105_P	Number	4	2
47	FED106_C	Text	1	
48	FED106P	Number	4	2
49	FED107C	Text	1	
50	FED107_P	Number	4	2
51	FED108_C	Text	1	
52	FED108_P	Number	4	2
53	FED198_C	**Text**	1	
54	FED198_P	Number	4	2
55	SITEPROB	Number	4	2
	***** TOTAL *****		**299**	

12.1 Data Terms and Definitions

Ave. Annual Energy (MWh) – The potential average annual generation of a project.

Text – Field type in Microsoft Access. May include letters, numbers, and punctuation symbols, as well as numbers that won't be calculated, such as phone numbers or zip codes.

Class – HES field name, project owner class code.

County Name – HES field name, the county a project is located within.

CULTUR_C – Resource database field name, stores Y, N, or blank value for environmental attribute Cultural Value.

CULTUR_P– Resource database field name, stores probability value for Cultural Value, dependent on CULTUR_C and Dam Status for its value.

DAMSTATUS – The status of a project from a development view. A project will either be "W" (with power), "W/O" (without power), or "U" (undeveloped project). W and W/O are sites with some type of structure present.

Environmental Attribute – The attributes that affect the PESF for a project in conjunction with the dam status of a project. Environmental attributes include the Federal Land codes, Recreation Value, and Fish Value, among others. A complete explanation is contained in Section 9 – Project Environmental Suitability Factor Determination.

Environmental Factors – The fields for entering whether an environmental attribute is applicable to a project. Answer a "Y" if applicable, answer "N" or leave blank if the environmental attribute is not present at a project site. The probability is computed dependent on the environmental factor and dam status.

Federal Land Codes – Defined in Section 9 – Project Environmental Suitability Factor Determination.

FED103_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 103.

FED103_P – Resource database field name, stores the probability value for Federal Land Code 103, dependent on FED103_C and dam status for its value.

FED104_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 104.

FED104_P – Resource database field name, stores the probability value for Federal Land Code 104, dependent on FED104_C and dam status for its value.

FED105_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 105.

FED105_P – Resource database field name, stores the probability value for Federal Land Code 105, dependent on FED105_C and dam status for its value.

FED106_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 106.

FED106_P – Resource database field name, stores the probability value for Federal Land Code 106, dependent on FED106_C and dam status for its value.

FED107_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 107.

FED107_P – Resource database field name, stores the probability value for Federal Land Code 107, dependent on FED107_C and dam status for its value.

FED108_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 108.

FED108_P – Resource database field name, stores the probability value for Federal Land Code 108, dependent on FED108_C and dam status for its value.

FED198_C – Resource database field name, stores Y, N, or blank value for Federal Land Code 198.

FED198_P – Resource database field name, stores the probability value for Federal Land Code 198, dependent on FED198_C and dam status for its value.

FERC Number – Federal Energy Regulatory Commission Number. FERC assigns a FERC number to any party owning a hydropower project or any party applying for a license to own and operate a hydropower project. The resource database contains projects that are not yet developed or licensed, but have been assigned a FERC number because a party is associated with securing a license for a project.

Field – Each item of information within a record (e.g., State, Plant Name).

FISH_C – Resource database field name, stores Y, N, or blank value for environmental attribute Fish Value.

FISH_P – Resource database field name, stores the probability value Fish Value, dependent on FISH_C and dam status for its value.

GEOL_C – Resource database field name, stores Y, N, or blank value for environmental attribute Geology Value.

GEOL_P – Resource database field name, stores the Geology probability value, dependent on GEOL_C and dam status for its value.

HES – Hydropower Evaluation Software. Uniform criteria and probability factor computer model to standardize the assessment process of potential hydropower in the U.S. Also manages the input, output, reporting, and data-storage of the resource database.

HISTORY_C – Resource database field name, stores Y, N, or blank value for environmental attribute History Value.

HISTORY _P – Resource database field name, stores the History probability value, dependent on HISTORY_C and dam status for its value.

HPRA – Refers to the Hydropower Resource Assessment database.

(KW) – Kilowatt, one thousand watts.

Kilowatt-Hour (kWh) – The amount of electrical energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

MW – Megawatt, one thousand kilowatts.

MWh – Megawatt-hours, one thousand kilowatt-hours.

Name Plate Rating – The maximum power output or load for which a turbine-generator, station, or system is rated. Used by HES to identify the additional capacity potential of a project.

OTHER_C – Resource database field name, stores Y, N, or blank value for environmental attribute Other Value.

OTHER _P – Resource database field name, stores the Other probability value, dependent on OTHER_C and dam status for its value.

Owner Name – The individual, group, or company owning a project, or applying for a license to develop a project.

PESF – The sum of all factors in the HES model that affect a project, or affect applying for a license to develop a project.

PESF*KW – The Name Plate Rating (KW), multiplied by the PESF, the sum of which is the HES model's potential hydropower for a project.

Plant Name – The name of the project.

Plant Type – The project type or type of operation.

Project Status – The project status code.

Project Suitability Factor – See PESF

REC_C – Resource database field name, stores Y, N, or blank value for environmental attribute Recreation Value.

REC _P – Resource database field name, stores the Recreation probability value, dependent on REC_C and dam status for its value.

Record(s) – All the data for a particular project.

Resource Database – The name of the database to store the Hydropower Resource Assessment data. The name for the resource database is hes.mdb.

River Basin – The river drainage a project is located in.

SCENIC_C – Resource database field name, stores Y, N, or blank value for environmental attribute Scenic Value.

SCENIC _P – Resource database field name, stores the Scenic probability value, dependent on SCENIC_C and dam status for its value.

Stream – The stream the plant is located adjacent to.

Structure – The names of fields in a record, the number of characters in a field, and the type of information allowed in each field, defines the database.

T_E_F_C – Resource database field name, stores Y, N, or blank value for environmental attribute Threatened/Endangered Fish.

T_E_F_P – Resource database field name, stores the Threatened/Endangered Fish probability value, dependent on T_E_F_C and dam status for its value.

T_E_W_C – Resource database field name, stores Y, N, or blank value for environmental attribute Threatened/Endangered Wildlife.

T_E_W_P – Resource database field name, stores the Threatened/Endangered Wildlife probability value, dependent on T_E_W_C and dam status for its value.

Undeveloped – Dam Status value indicating a project absent of any type of hydropower development, or any other type of structure impeding the stream flow.

Unit Type – The type of unit (i.e., Conventional, Reversible, or Missing).

WILDLF_C – Resource database field name, stores Y, N, or blank value for environmental attribute Wildlife Value.

WILDLF_P – Resource database field name, stores the Wildlife probability value, dependent on WILDLF_C and dam status for its value.

With Power – Dam Status value, indicating a project that currently has some type of hydropower in place.

Without Power – Dam Status value, indicating a project that currently has some type of structure that is an impediment to stream flow. Most likely a dam built for flood control or irrigation purposes. The structure would be absent of any hydropower.

13. ADDITIONAL SOURCES OF INFORMATION

James E. Francfort, Idaho National Engineering and Environmental Laboratory, P.O. Box 1625, Idaho Falls, Idaho, 84415-3875, (208) 526-6787.

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Bennie N. Rinehart, Idaho National Engineering and Environmental Laboratory, P.O. Box 1625, Idaho Falls, Idaho, 83415-3830, (208) 526-1002.

Mike J. Sale, Oak Ridge National Lab, Environmental Sciences Division, Building 1505, MS 6036, Bethal Valley Rd., Oak Ridge, TN, 37831, (615) 574-7305, (FTS) 624-7305.

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Jeff Waldon, MultiState Fish and Wildlife Information Systems Project, 102 Colony Park, 2001 South Main Street, Blacksburgh, Va. 24060, (703-213-7348).